The following requirements for type-testing of electric motors for hang- and paragliders are valid until included in the next revision of the LTF airworthiness requirements , as in accordance with LTF (Nfl II 91/09).

Additional Airworthiness requirements for hang- and paragliders in accordance with Nfl II 91/09 form 17.12.2009.

1 Electric motors for launch assistance

1.1 Validity

The following requirements are valid for all electric motor systems attached behind a pilot which enable self-launching a hang- or paraglider from flat ground, and thereafter largely unimpeded flight without the need for a winch tow system. Load limits of attachment equipment must not be exceeded through the use of the electric motor system. Additionally, the manufacturer must ensure all necessary attachment components (including sensors) required for system operation are clearly documented especially regarding placement and operation in the handbook. Harnesses and electric motors will be treated and tested as a single unit.

1.2 Definitions

1.2.1 Electric motor system

The electric motor system consists of a battery, battery management and re-charging system, electric motor, (if necessary) gearbox, controller, propeller shaft propeller and all controls (e.g. virtual cage), control panels and displays.

1.2.2 Battery

The primary source of electric energy

1.2.3 Charging system

The system used to fill the battery with electric energy

1.2.4 Electric motor

System for converting electric energy to mechanical energy

1.2.5 Motor controller

Device to regulate the output of the electric motor

1.2.6 Control System

Device to observe and regulate the status of all electric components in accordance with plausibility and safety checks.

1.3 Design and construction

1.3.1 General

The design of the electric motor system must ensure a minimum of safety risks for all pilots and observers during operation. Electric motor systems should only carry energy sufficient for attaining an altitude sufficient to allow continued flight through the use of thermals. The maximum energy must not exceed 3 kWh. Maximum acoustic emission is 50 dB (A) measured in accordance with present standards. Unimpeded flight should be possible once the electric motor system has been de-activated.

1.3.2 Temperature regulations for electric motor systems

Storage temperatures between -20°C and 50°C and operation temperatures between -10°C and 35°C should have not increase safety risks while operating the equipment.

1.4 Loading

1.4.1 Connection points of the electric motor system to the harness and other load bearing points on the system must withhold the following load limits for 10 seconds without failure.

1.4.1.1 forward: System weight x 9 g

1.4.1.2 up: System weight x 3 g

1.4.1.3 side: System weight x 1.5 g

1.4.2 down: System weight x 9 g

1.4.3 Should additional component attachment points be present, then these must also fulfil all requirements detailed in 1.5.

1.4.4 System weight is the total weight of the electric motor system, or in the case of 1.5.2, the sum of the component weights.

1.5 Battery

1.5.1 The battery used must be designed and fitted to provide minimum safety risk to the pilot. The battery must not explode, burn or emit poisonous or inflammable gasses in the event of a malfunction (overcharging, overloading, undercharging, short-circuiting, excessive temperature etc.) or crash. It must be ensured that cables do not catch fire. Operation and transport of the battery must be possible with minimum safety risk to the pilot. Appropriate measures must be taken to prevent short-circuiting, overcharging, overloading, overheating or the battery catching on fire. The battery must be fitted with a management system which prevents overloading, overheating and cell over- or under-voltage during charging and discharge should the battery not have these measures fitted within.

1.5.2 Significant performance reductions under full load operation should not occur. For this, the battery is to be tested on the ground over a period corresponding to 100% total capacity. External battery temperature must not exceed 45°.

1.5.3 All electrical connectors must be insulated, and ensure that false polarity connections are not possible. Short circuit protection during operation must be implemented.

1.5.4 Batteries must be clearly and durably marked with the following information:

1.5.4.1 Battery type

1.5.4.2 Number of cells

1.5.4.3 Min. and max. voltage

1.5.4.4 Max. charging and discharging current

1.5.4.5 Max. energy capacity

1.5.4.6 Volume (L/W/H in ccm)

1.5.4.7 Mass (daN)

1.5.4.8 Mass (daN) including cover

1.5.4.9 Manufacturer

1.5.4.10 Date of manufacture

1.5.4.11 Manufacturers serial number

1.5.4.12 The maximum energy capacity of the battery must not exceed 3kWh. A capacity display meter must be present. Capacities under 25% of the maximum must be displayed to indicate a warning.

1.6 Charging system

1.6.1 Charging systems must be appropriate for the batteries used, and configured by the electric motor system manufacturer. Electric connectors must ensure that false polarity connections to the battery are not possible.

1.6.2 Charging systems must be CE certified.

1.7 Electric motor and motor controller

1.7.1 The electric motor must be dimensioned to be able to provide sufficient power to launch, and fulfil the following minimum requirements at maximum take-off weight:

1.7.1.1 Climbing velocity of 1.0 m/s directly after the launch with a full battery.

1.7.1.2 Height gain of minimum 15 meters after a flight distance of 300 meters.

1.7.1.3 Risk to the pilot through fire, smoke, poisonous gasses or mechanical failure must be ruled out at all times.

1.8 Control system

1.8.1 The electric motor system must not be able to start accidentally.

1.8.2 The control system must constantly ensure safe operation of the motor. The control system must observe all necessary parameters defined by the manufacturer and regulate them should they approach their operation limits. Should a parameter exceed its safe operation limits, then the control system must ensure that the motor stops.

1.8.3 The control display must indicate the remaining battery capacity and all necessary parameters with their alarm limits required for safe operation.

1.8.4 Overload protection must be installed to shut down the motor, should for example the propeller or motor suffer a blockage. The protector must be placed between the battery and motor and separate these two units. An appropriate switch must be present to separate battery and motor. Overload protection must ensure that dangerous electrical currents do not build up and cause follow-on problems, should the propeller or motor suffer a blockage.

1.8.5 Electric connectors must be insulated and formed such that false polarity connections are impossible. Short circuit protection during operation must be implemented.

1.8.6 The motor must be immediately shut down, should an emergency parachute be deployed.

1.9 Electromagnetic radiation shielding

1.9.1 The electric motor system must be adequately shielded from external electromagnetic radiation such that this does not disturb operation. The electric motor must not emit electromagnetic radiation which disturbs other electronic devices or persons.

1.9.1.1 The electric motor system must conform to the following standards: EMVG § 7 p.2 or 3 top 1 and 2, EMVG § 8 p. 1 and § 9 (CE-standard), for emissions EN 61000-6-3 and EN 61000-6-1, EN 61000-6-4 and EN 61000-6-2. Appropriate documentation must be provided.

1.9.1.2 Documentation regarding compliance to human exposure restrictions in accordance with EN 62311 must be supplied.

1.9.1.3 Alternatively, compliance documentation may be attained from the Civil Aviation Authorities (e.g. VA 024 in its current version).

1.9.1.4 Repeated compliance documentation according to 1.10.1 when fitting the electric motor system to a different harness is only required should major modifications have been made to the system. Major modifications are in any case modifications to the entire electrical system.

1.10 Protection measures for rotating propellers

1.10.1 The electric motor system must be constructed to prevent a pilots limbs from contacting the rotating propeller during the start and in flight.

1.10.2 A rotating propeller must not be able to contact other parts of the glider during launching, while in flight or due to defects.

1.10.3 Third parties must be warned of a system ready to start by acoustic or visual warning signals.

1.11 Harnesses for electric motor systems

Harnesses for electric motor systems must fulfil all the requirements in place for paraglider harnesses for use without electric motor systems. In load testing in accordance with the LTF airworthiness requirements 4.2, pilot mass is to be replaced with start mass. Start mass is the sum of pilot, harness, reserve parachute and electric motor system (incl. battery) masses.

1.12 Propeller loading

1.12.1 Bearings, blade connectors and propeller blades must support a load twice that of the load reached at the maximum propeller rotation speed. Documentation can be supplied in calculated form, or from static or dynamic load testing.

1.12.2 Calculated / static loading is to be performed according to:

$Fzug\_p = 2 \times Fz$

with

$Fz = m \times (2 \times \tau \times n)^2 \times r$

where:

m = weight per blade(N)

Pi= Pi Constant

n = Maximum revolutions / minute (U/min)

r = Propeller centre of gravity radius (m)

Fz = Force (N)

Fzug_p = calculated force for static loading (N)

1.12.3 Dynamic load documentation: the maximum revolutions per minute of the motor is to be calculated as follows:

nprüf = n x 1,5
with
nprüf = Test revolutions per minute (U/min)
n = maximum propeller revolutions per minute (U/min)
The propeller must be able to withstand 15 minutes at the desired test revolutions per minute without damage.

1.13 Distance from propeller to other parts of the glider

The minimum radial distance from the end of the propeller blades to other parts of the glider must not be less than 5 cm. Particular attention should be given to sprung components or mountings with a degree of play. Minimum axial distance from the propeller to the motor or gearbox is 1 cm. Should moveable components be present, then the minimum distances are valid for the most unfavourable configuration.

1.14 Vibration damping

Vibration damping components must be present between the electric motor system and its mounting. These components should prevent vibrations from acting on the mounting framework as much as possible. It must be ensured that the motor does not detach from its mounting should a vibration damping component suffer a failure.