Commentor	Austro Control (ACG)
Paragraph	**General**
Comment	Based on our Experience with Experimental Electric Powered Sailplanes (HK36) we have reviewed the EASA SC proposal and have the following Austro Control comments. First, we appreciate the EASA approach and generally supporting the SC. It seems that the sailplane community is again a starting point for modern technologies in certification, that is good!
Response	Noted

Commentor	European Glider Manufacturers and Suppliers association
Paragraph	**General**
Comment	The European sailplane manufacturers very much appreciate the proposed special condition (SC), as this will hopefully become a reliable basis for different projects to install electric propulsion systems in sailplanes. The manufacturers have observed the possibilities of electric propulsion over the recent years in several experimental projects and now the time is ripe to bring such systems on the market with according regular EASA certification. The SC will give such applicants the possibility to develop reliable and safe systems which also must stay in the rather tight financial possibilities offered by powered sailplanes. At least as important is the hope of manufacturers and interested customers alike, that electric propulsion units offer a vast improvement with respect to easy and foolproof activation, better gliding performance in the case of an engine malfunction and better durability due to the nearly nonexistent vibration. This will all lead to much safer systems when compared especially to the original and now rather old two-stroke systems which opened the market for sailplanes with retractable engines. And last but not least everyone welcomes the prospect of nearly completely silent engine operation. The pilot now gets a quiet environment without the distraction of noise and vibration and the airfield neighbors will appreciate the absence of noise and other emissions. Nevertheless all developers of these new propulsion systems realize that this family of engines and associated systems for control and energy storage will

	see considerable development and optimization in the next years. Therefore the manufacturers willing to take this challenge need some opportunity to make the necessary steps on this road to an even better propulsion system. This makes it necessary to have a basis for certification and exactly that will become possible when EASA will offer the proposed SC to such applicants. In the following comments to several single points in the SC some questions and suggestions are forwarded to EASA – all come from companies which are already developing such electric propulsion systems or plan to do so in the near future. All comments had in common the appreciation that this SC will offer a good starting point for these projects. Besides offering a fixed certification basis it is also applauded, that due to the still rather small knowledge basis, additional assessments will be needed to come to reliable and safe solutions. In this not yet fully mapped territory only good engineering judgment will help to develop solutions which will be technically sound and also comply with the requirements.
Response	Noted

Commentor	Alexander Schleicher GmbH & Co. Segelflugzeugbau
Paragraph	**General**
Comment	We appreciate, that EASA intends to set the certification basis adjusted to the possibilities and resources of small aviation manufacturers. In this context it cannot be stressed enough, that all propulsion units in powered sailplanes are only auxiliary means the basis is a sailplane with all its operational limits. Therefore it cannot be expected, that these auxiliary propulsion units have the same reliability as it is necessary for example in IFR-operation. Correspondingly no safety assessments according to CS 2x.1309 or qualification of control units according to DO standards are usual, like stated by EASA. Nevertheless the risk of catastrophic failures can be minimized, if all critical items are handled with good engineering judgment. It is also pointed right by EASA, that a simple and reliable start procedure of an electric propulsion will improve significantly the safety in comparison to existing propulsion systems. This special condition is very important for all glider manufacturers, because it sets reliable rules for the further developments of electric propulsion in motor gliders for the next years.

	Clarification would be usefull with respect to the notes: Are the notes part of the requirements, maybe as Interpretative/Explanatory Material, or are they to be understood as AMC-material?
Response	Agreed; notes will be clarified.

Commentor	Diamond Aircraft Industries
Paragraph	**General**
Comment:	Diamond developed a technology demonstrator for an electric/hybrid propulsion system on it's powered sailplane HK 36. The demonstrator airplane as an Annex II airplane, but nevertheless we herewith want share our experience. Some areas are already or at least partly addressed in the special condition as published. In general, the *special condition* as published addresses individual components but does not explicitly introduce requirements of the entire system design and behavior. Major parts of an electric propulsion system in a powered sailplane are similar to those used in the Formula SAE (Formula Student); hence, a view to these rules (Part EV – Technical Regulations – Electric Vehicles) can provide practicable hints on regulation structure and implementation of technical details. The system design voltage is an important parameter for safe operating and handling characteristics. Therefore, it seems to be useful to distinguish low voltage (LV) systems (where there is no immediate danger to the human body) and high voltage (HV) systems; a limit value may be in the range of 40-60 VDia Subsequent requirements may be tighter or applicable only when the system voltage is above the specified limit value. Li batteries (the type of batteries most likely to be used for propulsion of airplanes) have some characteristics that have to be assessed during certification and operation: - A narrow thermal operation range: high temperatures can lead to failure of the battery including hazards to the airplane, low temperatures reduce the available power and may make take-off unsafe or impossible - The focus on potential hazards to the airplane shifts from (combustion) engine compartments to energy storage compartments, from engine firewall to battery containment. Automatic safety systems to ensure safety of pilot, maintenance and handling personnel and rescue personnel should be provided for HV systems. A shut-down circuit (interlock) which runs through all safety relevant parts of the

	system should disable the HV circuit (i.e. disconnect the battery isolation relays, see CS 22.1353(f) below). It should be possible to activate the HV system only when the shut-down circuit is closed. If the shut-down circuit is interrupted at any point, the HV batteries should be disconnected by opening the battery isolation relays. These safety relevant parts are HV master switch, emergency shut-down button, isolation monitoring device (cf. CS 22.1365(e) below), and all connectors in the HV power lines. An acceleration sensor might also be an option to interrupt the shut-down circuit in case of an emergency, reacting to forward acceleration like in an ELT, to provide automatic shut-down of the HV circuit in case of a crash landing. After opening the battery isolation relays, the voltage in the HV circuit should automatically drop to a safe level in a reasonable time (5-10 sec). An indication may be considered to show (to pilot and maintenance personnel) when the voltage in the HV circuit is above the low voltage limit. A "Hot System Indication" should be required to indicate to persons next to the airplane that the HV-System is activated. The main intent is to indicate that a sudden start of rotation of the propeller is possible. This indication could be acoustical and/or optical. External marking should be considered indicating the presence of Li batteries and a HV system, where applicable.
Response	Partly agreed: see modification to CS22.1353 and 22.1365. The valuable information and guidance is very much appreciated and the advice to ensure safety of pilot, maintenance and handling personnel and rescue personnel with regard to the high voltage system is considered.

Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	**General**
Comment:	Throughout in the document the terms "accumulators", "batteries", "source of energy" and "energy storage devices" are used at different places. Perhaps it could be useful to have a "Definitions" section to introduce a clear definition as – depending on the mother tongue of the reader – the meaning of these terms could be interpreted differently. Additionally it should be clearly specified if in certain paragraphs the battery as a whole, a single string (in the case of several batteries in parallel, or a single element (several battery cells in parallel) or a single battery cell (the smallest unit) is addressed. Again this could be perhaps put into a Definitions section. Also the term EMI should be defined; especially it should be avoided here to ask for extensive laboratory testing procedures but to specify potential

	scenarios which have to be assessed.
Response	Agreed: The problem is understood and agreed. Definitions in the context of this special conditions will be amended.

Commentor	Austro Control (ACG)
Paragraph	**General**
Comment	**Definition Propulsion Unit** It seems to be important to have a clear definition of a ”Electric Propulsion Unit”. It should include as a minimum: engine, battery, cables, control units
Response	Noted: Definitions will be added, but definitions like “electric propulsion unit” or “engine” might be different in different projects. It is important in every project to clearly identify and define the interfaces.

Commentor	Austro Control (ACG)
Paragraph	**General**
Comment:	**Li Batteries** Related to the Statement of Issue it is not clear if this SC is also applicable for the installation of a LI-main battery (Low Volt) or for a engine main battery. We support to have a SC for the installation of Li Batteries in sailplanes as a replacement for current lead acid batteries. If they are allowed for engine batteries, the same conditions should allow the installation as a main battery, which might be not so critical as long as the recharging is done external and not in flight. We propose to create a separate SC called “Li batteries in sailplane CS22 installations”
Response	noted. The applicability of this SC is installations of electric propulsion units. Even when elements might be adequate for sailplanes as replacement for current lead acid batteries an independent SC seems to be appropriate.

Commentor	Austro Control (ACG)
Paragraph	**General**
Comment:	**Hybrid Systems** It is not entire clear if hybrid systems currently in development or in experimental status are covered by this SC. Such systems may allow one takeoff and following sustained flight in the hybrid modus.
Response	Partly agreed: The applicability of this SC is installations of electric propulsion units powered sailplanes. The applicability installations of hybrid systems in powered sailplanes needs to be checked. The scope will be added.
Commentor	European Glider Manufacturers and Suppliers Association

Paragraph	**General**
Comment:	Several "notes" are included – perhaps it could be useful to mark them as AMC or GM (as appropriate) as this will clarify if these notes are considered as possible showing of compliance or additional information.
Response	Agreed. Notes will be clarified

Commentor	Diamond Aircraft Industries
Paragraph	**CS 22.1 Applicability**
Comment	CS 22.1 (a)(2) should not be limited to combustion engines, but include electric propulsion
Response	Agreed
wording	CS 22.1 (2) to be read powered sailplanes the design value W/b2 (weight to span2) of which is not greater than 3(W[kg], b[m]) and the maximum weight of which does not exceed 850 kg; and

Commentor	Austro Control (ACG)
Paragraph	**General**
Comment	Independent from this certification SC, additional actions may be required to properly train Part 66 personal regarding this systems.
Response	Noted; problem is understood and agreed but cannot be addressed in certification, Part 66 L-Licenses should cover this. Although powered sailplanes will belong to type rating group 4, Part-66 staff has to make sure to have the respective type specific knowledge. The same principle should apply to certifying staff under national regulation currently.

Paragraph	**CS 22.561**
Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Comment	No comments
Response	Noted

Commentor	Alexander Schleicher GmbH & Co. Segelflugzeugbau
Comment:	The requirement of 15g ultimate inertia load in forward direction for the

	fastening of the energy storage device is justifiable. Justification: The 15g in forward direction agree with the existing emergency landing requirements.
Response	Noted

Commentor	European Glider Manufacturers and Suppliers Association
Comment:	15g requirement for emergency landing We assume that this requirement has been drafted for the case that the battery is installed behind / above the pilot (see 22.561 (e)). Perhaps this wording could be added in (f) also as such a requirement would be not needed if the battery is for example in the nose of the sailplane.
Response	Not agreed . "installed in such a way that the pilot(s) could be endangered in the emergency landing case" is seen to be adequately addressing the problem

Commentor	Diamond Aircraft Industries
Paragraph	CS 22.891-897 Water Ballast Paragraphs
Comment:	Batteries should be protected from possible water ballast leakage.
Response	agreed; will be regarded 22.1353 (g)

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.902
Comment	No comments
Response	Noted

Commentor	Diamond Aircraft Industries
Paragraph	CS 22.903 Engines
Comment:	Mentioning the applicable special condition (e.g. LBA I 421-Elektro-97) for electric engines would clarify the requirement.
Response	agreed CS 22.903 (a) Engines to be read (a) The engine must meet the special condition for electrical engines established by the Agency.

Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	**CS 22.1165 now integrated in 22.951(a)**
Comment	– Capacity of battery for a self-launcher Perhaps a wording like "In case of a self-launching powered sailplane, the capacity of the batteries must allow at least… …plus one minute reserve at the recommended climb-power setting plus sufficient power for use of electrical systems during the following un-powered flight continuation" would be more straight forward? In point (c) we suppose that the electric circuit of the propulsion system should be not directly connected to the electrical bus system of the other sailplane electric systems.
Response	agreed; requirement moved to more appropriate location 22.951 and clarified.

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Para:	CS 22.951
Comment:	(c) A protection against overcharge and over-discharge… Acronym "EMI"- probably this mean Electro Magnetic Influence?
Response	Agreed, requirement is amended

Commentor	Diamond Aircraft Industries
Para:	CS 22.951 General
Comment:	Equal charge and *dis*charge of the energy storage should be ensured.
Response	Agreed, requirement is amended.

Commentor	Austro Control (ACG)
Paragraph	General
Comment	Wind milling Effects The Electric effects of the system in a wind milling condition (e.g. prop brake

	not effective), when the Engine works as a generator shall be considered.
Response	Agreed: paragraph amended

Commentor	Austro Control (ACG)
Para:	
Comment:	**Engine Spool Up (torque Limit)** The electric engine provide a high torque when electric power supplied. Means must be installed to ensure a controlled soft engine spool up avoiding overstress variouse components.
Response	Partly agreed: The electric propulsion system including engine mount and propeller must be able to take the maximum loads produced by the engine. CS22.361(c)

Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	**CS 22.951 (b)**
Comment	equal charge and discharge (?) We suppose that in the requirement an equal discharge of batteries is asked for. Of course the same is useful if charging is being done. In the note the wording "this requirement is accepted as valid" could perhaps be changed to "Compliance (with this paragraph) may be provided by…"
Response	Agreed; wording clarified

Commentor	Alexander Schleicher GmbH & Co. Segelflugzeugbau
Paragraph	CS 22.951 (c)
Comment	The defined requirements are reasonable to ensure a safe operation of the electric propulsion. But showing the compliance with EMI, environmental and software aspects must not require larger efforts than for similar tasks at conventional powered sailplanes (for example without tests in EMI-laboratories). We understand the term "good engineering practice" used

	in this wording is similarly to what is described in 963(b). Experience and an analytic mind is used to process the available information to identify possible failure modes. These possible failure modes are then addressed in the design. Justification Compared to CS 23 or bigger aircraft, simpler means to show compliance with EMI, environmental and software aspects were successfully applied. This is based on good engineering practice and the nature of the propulsion being only an auxiliary addition.
Response	Noted: EMI tests for equipment in small aircraft are normally done by quite simple ground test.

Commento	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.959
Comment	No comments
Response	noted

Commentor	Alexander Schleicher GmbH & Co. Segelflugzeugbau
Paragraph	**CS 22.959**
Comment:	This paragraph could be misunderstood and should be defined more precisely. Justification The paragraph could be understood, that the unusable remaining energy quantity shall be displayed at low-level. Probably the correct meaning is, that by reaching the unusable energy quantity a low-level indication should be given. Furthermore it should be considered, that in contrast to fuel the unusable remaining energy quantity of batteries is not constant but a function of temperature, life time, power requested by pilot, etc. Proposed Text The unusable remaining energy quantity shall be established and by reaching this unusable remaining energy quantity a low-level indication shall be displayed (see CS1553). Note: unchanged [some design might prevent ... restored after flight] additional to this note: In case of certain battery types voltage might be a

	better measure for protection against under-discharge as their assumed or calculated remaining energy. Therefore, low level indication may also be given based on voltage.
Response	Partly agreed, the display of needed information is handled in 22.1553

Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	**CS 22.959**
Comment	unusable remaining energy quantity Of course this paragraph is similar to the "unusable fuel" of the original 22.959. Nevertheless the spirit of the original para is to prevent the pilot to expect power from the propulsion when this amount is reached. Therefore beside showing an energy level as written it might be also possible to warn here by showing a voltage level. The wording should perhaps require that the pilot gets regarding indication if this unusable remaining energy level is approached / reached.
Response	Agreed, the display of needed information is handled in paragraph 22.1553

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.963
Comment	The problem of UN T38.3 test requirements is that beside testing of cells which is performed by manufacturers of the cells, there is also a requirement about testing of battery packs. This is not a big deal in case of small packs, but it is a very expensive for a big packs. It is required about 24 packs for testing, and in our case this would cost more than 70K€ for packs + another 10K€ for test procedure itself!
Response	Agreed, note will be amended.
Commentor	Alexander Schleicher GmbH & Co. Segelflugzeugbau
Comment:	We would ask for clarification of the Note in 22.963(b) of the term 'battery'. We think the intention of the authors is rather 'battery cell'. If the whole energy storage device would have to be qualified according to the named standards, the paragraph before the note would not be necessary. We understand that the battery cells and other components should be selected from quality material. In case of battery cells this should be documented by accepted standards. The assembly then has to be designed so that sensible answers to the possible failure modes are incorporated. It is known, that problems of other battery installations in the past have shown, that the installation of critical battery types needs an increased

	attention. Unfortunately the qualification of the whole energy storing device according to accepted standards (e.g. DO 311, UN T 38.3) is a too big financial challenge for small aviation manufacturers. This must be seen under the light that it is not yet decided if electric propulsion will widely be accepted by customers, and low numbers of production may be faced. Nevertheless electric propulsion offers a too promising chance for safer and environmentally friendlier general aviation. It is also plainly visible, that there is only few experience available in the operation of electrically powered sailplanes. But it is in the interest of every manufacturer to deliver safe products. And just because there might be a certain learning curve, test requirements must not be too high. Otherwise it would practically not possible to improve systems in small steps. It also may be regarded, that different types of cells contain different inherent risks, and therefore a different level of testing may become necessary. Proposed Text Note: Battery cells should be qualified according accepted standards (e.g. DO 311, UN T 38.3).
Response	Agreed, note will be amended.

Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	CS 22.963 (b)
Comment	Several commenter pointed out that tests according to such standards (as DO 311 or UN T 38.3) will be useful for single battery cells (the smallest sub-element within the fully assembled battery) but not for the full system.
Response	Agreed, note will be amended.

Commentor:	"Sportine aviacija ir Ko", LZ design d.o.o
Para:	CS 22.967
Comment:	(b) If there is really small risk about vapours, then ventilated battery compartment is maybe not the best way, as in case of fire such ventilation provide a fresh oxygen which is required for sustained fire. (c) … and that no ~~leaking fuel and~~ vapours will have… (d) only heavy steel structure would be able to withstand high thermal loads under fire, but such arrangement would be simply too heavy for powered sailplanes.
Response	Partly agreed: CS 22.967 (c) is corrected to fluids. CS 22.967 (d) ensuring the surrounding structure might be able to withstand the thermal loads is not the only option to address the failure modes thermal runaway or fire but the failure mode if existing needs to be addressed at least the frequently mentioned "god engineering judgement". It is not the intention

	of the SC to mandate prescriptive design solutions.

Commentor	Diamond Aircraft Industries
Para:	**CS 22.967 (e)**
Comment:	**CS 22.967 Installation of energy storage devices** (e) The effects of moisture and rain to possibly vented battery units in vented battery compartments should be investigated and appropriate protection of HV equipment should be realized.
Response	Agreed; added to CS 22.1353

Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	**CS 22.967 (b)&(c)**
Comment	ventilation / drainage It has been asked here if it would be also acceptable if this volume would be contained and/or closed with a device only opening in case of over-pressure. In the case of (c) it is fully supported that neither fluids nor gaseous emissions must be allowed to impair the occupants.
Response	Noted: If vapours may separate from the container in case of overpressure this can be ensured by a valve releasing the vapour but the compartment needs to be ventilated.

Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	**CS 22.**
Comment	22.967 (d) – minimizing failure effects Perhaps the assessment should include to develop regarding recommendations to the pilot as "stop engine" / "land asap" / "land immediately" / "bail out".
Response	Noted: The above commands would fall under the options of 22.967 (d) first bullet point 1, but to "bail out" seems not to be a minimized effect.

Para:	CS 22.1041
Commentor:	"Sportine aviacija ir Ko", LZ design d.o.o

Comment:	No comments
Response	noted

Commentor	Diamond Aircraft Industries
Paragraph	**CS 22.1041 Cooling – General**
Comment	Attention should be paid also to low temperatures, as far as Li batteries are concerned, because this can significantly reduce available power output. After long flights in cold conditions (e.g. high altitude flights) it can be expected that also the batteries are cold (cf. water ballast requirements).
Response	partially agreed; not related to cooling but the problem is understood and addressed in new CS 22.1553 (c)
Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	CS 22.1041
Comment	– cooling Instead of "maintain" perhaps "prevent exceeding temperature limits" should be used.
Response	Not agreed: the objective is to maintain temperatures within the established limits.

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1047
Comment	(a)(1) … climb with maximum continuous power in case of self-sustaining sailplanes (a)(2) We do not understand this completely.
Response	Agreed: wording improved.

Commentor	European Glider Manufacturers and Suppliers Association
Comment:	– cooling flight test Under (a)(2) we assume that "low-level" is equivalent to the level as specified under 22.959. The wording "at most for 5 minutes" could be also "this test segment needs not to be longer than 5 minutes." Under (d) we understand that this test shall be conducted at 38°C. If the outside air test temperature is different, then all measured temperatures shall

	be corrected by addition of this temperature difference? Perhaps a formula like T_corrected = T_component + (38°C – T_outside) could help?
Response	Agreed: wording improved.

Commentor	Austro Control (ACG)
Para:	**General**
Comment:	**Cooling test procedure** The proposal 22.1047(a)(2) is not understood and therefore not clear. We assume max.cont power climb within the limits and afterwards …? Which limits – engine, battery or ? What has to be done than ?
Response	Agreed: wording improved.

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1091
Comment	No comments
Response	Noted

Commentor:	"Sportine aviacija ir Ko", LZ design d.o.o
Para:	CS 22.1103
Comment:	No comments
Response	Noted

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1125
Comment	No comments
Response	noted

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o

Paragraph	CS 22.1141
Comment	No comments
Response	noted

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1145
Comment	Ignition switches. What exactly it is meant ignition switch? It could be a switch which turns ON a power supply to motor controller electronic or it could be a switch which turns ON a power supply of main contactor?
Response	Agreed: CS 22.1145 is modified

Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	**CS 22.1145**
Comment	– Ignition switch Perhaps this term should be replaced by "engine master switch" or another term. The word ignition has triggered some questions as this is typically associated with a combustion engine.
Response	Agreed CS 22.1145 modified accordingly

Commentor	Austro Control (ACG)
Para:	
Comment:	**Start Up Protection.** As usual on combustion engine, a engine spool up/start by only one pilot action must be avoided. A system shall be installed that have an Engine Master Switch (HIGH DC POWER or Engine Master) in addition to the Master Switch (Low DC Power – Ship System). In Addition, the system must be designed in a way that the engine will start running only if the Power Lever is first in the Start (Min-OFF or Idle) Position. GM: This system shall protect an inadvertent engine run when the engine master is switched on and the Power Lever is forward (Above Idle)
Response	Agreed: CS22.1145 modified accordingly

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1149

Comment	No comments
Response	Noted

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Para:	CS 22.1165
Comment:	(a)…. energy storage devices must be at least large enough that a take-off or climb (for self sustaining gliders)…. (c) This is not clear to us, what is really a detached circuit? Usually DC/DC converter supply a 12V also to other instruments, not only to motor instrument and motor controller electronic (FCU in our case). Or maybe here is meant something else?
Response	Agreed: there is no ignition system. Content partly moved and paragraph is deleted.

Commentor	European Glider Manufacturers and Suppliers Association
Paragraph	**CS 22.1165**
Comment	– Capacity of battery for a self-launcher Perhaps a wording like "In case of a self-launching powered sailplane, the capacity of the batteries must allow at least… …plus one minute reserve at the recommended climb-power setting plus sufficient power for use of electrical systems during the following un-powered flight continuation" would be more straight forward? In point (c) we suppose that the electric circuit of the propulsion system should be not directly connected to the electrical bus system of the other sailplane electric systems.
Response	Agreed: there is no ignition system. Content partly moved and paragraph is deleted.

Commentor	Austro Control (ACG)
Para:	**22.1165(a) Minimum Capacity**
Comment:	22.1165(a) is unclear, we propose the following (a) If the self-launching of a powered sailplane shall be authorized, the capacity of the batteries, accumulators or any other energy storage devices must be at least large enough that a take-off to an altitude of 360 m (22.65) in the conditions of 22.45 is possible. The minimum capacity for a safe takeoff when meeting this requirements shall be clearly indicated to the pilot (AMC: A green or red go/No go light or a red minimum capacity indicated is acceptable) . We do not think that 22.1165 is good number for that item.

Response	Agreed; moved to 22.951, indication is addressed in 22.1553, as there is no ignition system rest is deleted.

Commentor	Austro Control (ACG)
Para:	**CS 22.1165(c)**
Comment:	**Detached Circuit** 22.1165(c), it is not understood what a detached circuit is.
Response	Agreed: there is no ignition system. Content partly moved and paragraph is deleted.

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1191
Comment	No comments
Response	Noted

Commentor	Diamond Aircraft Industries
Paragraph	**CS 22.1191 Firewalls**
Comment	In the case of an electric propulsion powered by Li batteries, the engine is less a fire hazard than the batteries; hence, this paragraph addressing firewalls should be pointed more towards energy storages and speak of containments rather than firewalls (cf. CS 22.967 (d) and CS 22.1353(e)).
Response	Noted; this is understood and the reason why this requirement only asks for a firewall when there is the risk of a sustaining fire.

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1193
Comment	No comments
Response	Noted

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1305
Comment	No comments

Response	Noted
Commentor	European Glider Manufacturers and Suppliers Association
Para:	CS 22.1305(e)
Comment:	power-plant instruments Under (e) we propose the wording of the original 22.1305 – elapsed-time indicator
Response	Agreed; original wording is kept

Commentor	Diamond Aircraft Industries
Paragraph	CS 22.1337 Power-plant instruments
Comment	(a)(1) Referres to a deleted paragraph (CS 22.993)
Response	Agreed; CS.1337 to be deleted for this SC

Commentor:	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1353
Comment:	No comments
Response	noted

Commentor	Diamond Aircraft Industries
Paragraph	**CS 22.1353 Design and installation of accumulators and other sources of energy**
Comment:	The following guidance should be added (d) Batteries should be encased units of rugged design. Besides mechanical requirements to resist air, ground, and emergency landing loads, the casing has to act as a containment, as needed by the potential hazards depending on the battery cell's chemistry, and should have proper venting and a pressure relief valve in case of emission of gases. A maximum energy per contained unit might be considered. (-) The battery casing should include battery isolation relays to

	connect/disconnect both poles of the HV battery (for activation and regular or emergency shut-down of the HV system). (-) The battery casing should include a proper fuse.
Response	Agreed; requirements modified (see also 22.1365)

Commentor	Austro Control (ACG)
Para:	**CS 22.1353**
Comment:	**Mechanical Shutoff** A mechanical shutoff at the energy storage is an direct safety Issue for Pilots and Mechanics when handling the Battery system. This ensure that the on board system is voltage free. Therefore the Note 22.1353 shall be replaced by an requirement (f), the text should be amended as following: A mechanical operated main shut-off of the battery energy storage device should be considered. This shut-off shall not rely on any processor or software actions to provide electrical isolation of the battery. AMC: This Shutoff must not be operated from the cockpit, additional system features to isolate the Battery from the system may be provided separately.
Response	Partly agreed, the notes in the draft SC have been converted to requirements, AMC or GM as appropriate.

Commentor	CAA UK
Para:	**CS 22.1353**
Comment:	Comment: The "Note" after paragraph (e) should be a separate paragraph identified as (f) to make it a requirement. As a note, it could be read only as AMC. Justification: Inclusion of the shut-off paragraph as a note rather than a separate requirement paragraph could be interpreted as it not needing to be complied with, that it is for information only. However, it addresses what would otherwise be a potential unsafe condition, so it deserves a separate entry. Proposed Text (if applicable): Amend "Note: A pilot/mechanic operated main…" to "(f) A pilot/mechanic operated main…"
Response	Agreed, the notes in the draft SC have been converted to requirements, AMC or GM as appropriate.

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1365

Comment	(e) Should be battery minus pole grounded? Then is not really fully electrically isolated... (f) Usually they are easy identifiable as they have much higher cross section (diameter) than low voltage cables. And from which voltage level they are treated as "High Voltage"?
Response	Partly agreed; both poles should be disconnected. Higher cross section is not accepted to identify high voltage cables.

Commentor	Diamond Aircraft Industries
Paragraph	**CS 22.1365 Electric cables and equipment**
Comment:	The following guidance should be added (-) All parts used in the HV system should be rated for the voltages and currents subjected to. (e) An isolation monitoring device (IMD) should be installed. Available devices may have two threshold indications: warning and critical (interrupting the shut-down circuit). (e) No pins of connectors in the HV system should be exposed while under battery voltage. For systems with multiple connectors, e.g. with more than one battery unit, an interlock should be considered which automatically disconnects all batteries when a single connector is opened. (f) Similar to cockpit controls, a standardized color code for all high voltage components (e.g. bright orange) should be considered. Warning placards marking HV components should be applied.
Response	Agreed; Requirement changed and guidance added.

Commentor	European Glider Manufacturers and Suppliers Association
Para:	**CS 22.1365**
Comment:	Electric cables Under (d) we assume that here gain EMI effects need to be considered.
Response	Noted

Commentor	Austro Control (ACG)
Para:	**CS 22.1365**
Comment:	**High Voltage System Protection and Isolation Monitoring** See also 6)

	High Voltage (above 40V) components such as wirings, assemblies, control units must have an independent monitoring of the system which automatically indicate a failure of the isolation to the pilot. Common used systems with +400VDC have an ultimate safety hazard to pilot/pax/mechanic when not properly protected. AMC: An Automatic Shutoff may only be acceptable if such a system do not create an additional hazard regarding a safe flight. Therefore 22.1365 shall be amended: • The ground fault system which includes shielded/protected cables shall be mandated and not noted, with reference to international standards • A main fuse located direct at the energy storage must be installed to isolate the system in case of a short circuit.
Response	Agreed;

Commentor	Austro Control (ACG)
Para:	**CS 22.1365**
Comment:	**Separation of High Voltage Components** High Voltage Systems are common used on that installations. These installations are sensible especially regarding sparking and Human Safety. This needs special installations provisions and protections very similar to photovoltaic or electric car installations. There are various standards available which should be considered and included. Following minimum should be added in 22.1365: - Physical Separation of fuel lines to high voltage cables - Physical Separation of control system to high voltage cables - Physical Separation of low voltage to high voltage cables
Response	Agreed: requirement modified

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1365
Comment	At Definition and Terminology of the SC, the specified High voltage range is defined as: *High voltage (HV) - Classification of an electric component or circuit, if its working voltage is > 60 V and _ 1500 V DC or > 0 V and _ 1000 V AC root mean square (rms).* It seems that this definition was simply taken from from Formula SAE rules. Formula Student cars are using 300V or 600V, and they just marked this as HV compared to other LV wirings at 12V. Such classification is not correct. The International Electrotechnical Commission (IEC), has a more detailed specification of voltage ranges (IEC 61140), as one of several other means to protect against electrical shock.

IEC voltage range	AC	DC	defining risk
High voltage (supply system)	> 1000 Vrms	> 1500 V	electrical arcing
Low voltage (supply system)	50–1000 Vrms	120–1500 V	electrical shock
Extra-low voltage (supply system)	< 50 Vrms	< 120 V	low risk

IEC defines additional three types of **Extra-low-voltage** systems, ordered from most restrictive (safest), to least restrictive.

1. Separated extra-low voltage (SELV)
2. Protected extra-low voltage (PELV)
3. Functional extra-low voltage (FELV)

1. Separated extra-low voltage (SELV)
IEC defines a SELV system as "an electrical system in which the voltage cannot exceed ELV under normal conditions, and under single-fault conditions, *including* earth faults in other circuits".

A SELV circuit must have:
- protective-separation (i.e., double insulation, reinforced insulation or protective screening) from all circuits other than SELV and PELV (i.e., all circuits that might carry higher voltages)
- simple separation from other SELV systems, from PELV systems and from earth (ground).

The safety of a SELV circuit is provided by:
- the extra-low voltage
- the low risk of accidental contact with a higher voltage;
- the lack of a return path through earth (ground) that electric current could take in case of contact with a human body.

2. Protected extra-low voltage (PELV)
PELV system as "an electrical system in which the voltage cannot exceed ELV under normal conditions, and under single-fault conditions, *except* earth faults in other circuits".
A PELV circuit only requires protective-separation from all circuits other than SELV and PELV (i.e., all circuits that might carry higher voltages), but it may have connections to other PELV systems and earth (ground).
In contrast to a SELV circuit, a PELV circuit can have a protective earth (ground) connection. A PELV circuit, just as with SELV, requires a design that guarantees a low risk of accidental contact with a higher voltage.

3. Functional extra-low voltage (FELV)
The term functional extra-low voltage (FELV) describes any other extra-low-voltage circuit that does not fulfil the requirements for an SELV or PELV circuit.

Response	Agreed: CS 22.1365 is modified

Commentor	CAA UK

Para:	**CS 22.1365**
Comment:	Comment: The "Note" after paragraph (e) should be a separate paragraph identified as (f) to make it a requirement. As a note, it could be read only as AMC. Existing paragraph (f) should then be changed to (g). Justification: Inclusion of the ground fault detection paragraph as a note rather than a separate requirement paragraph could be interpreted as it not needing to be complied with, that it is for information only. However, it addresses what would otherwise be a potential unsafe condition, so it deserves a separate entry. Proposed Text (if applicable): Amend "Note: A ground fault detection system…" to "(f) ground fault detection system …" Change "(f) High Voltage cables have to be clearly identifiable." To "(g) High Voltage cables have to be clearly identifiable."
Response	Agreed, the notes in the draft SC have been converted to requirements, AMC or GM as appropriate.

Commentor	"Sportine aviacija ir Ko", LZ design d.o.o
Paragraph	CS 22.1553
Comment	No comments
Response	Noted

Commentor	Diamond Aircraft Industries
Paragraph	**CS 22.1553 Energy quantity indicator**
Comment	If required by the battery technology used, this paragraph should also include energy storage device status, such as temperatures and available power. In the case of Li batteries with their internal resistance changing significantly with temperature variations, the available power is of interest to the pilot. A cold battery may have to be heated (externally or by active BMS) prior to the extraction of design power, e.g. for take-off or go-around, or permanently.
Response	Agreed: Requirement CS22.1553(c)and GM added

Commentor	European Glider Manufacturers and Suppliers Association

Paragraph	**CS 22.1553**
Comment	– Energy quantity indicator Similar to 22.959 we propose that it should be also possible to indicate other possible variables which are equivalent the energy level. Often a voltage level might be here also adequate. Or the difference of the voltage of the battery cell with the lowest voltage against a set minimum voltage. Experience has shown that accurately measuring the energy consumed is rather difficult and therefore sometimes unreliable. A final comment from my personal experience with many rulemaking discussions for sailplane airworthiness codes: we all should never forget that failure of the propulsion system in a sailplane might be not a critical event as long as it is designed as a motorglider in the original definition: by stopping the engine it becomes a sailplane. Of course such failures must not injure the occupants or impair the necessary actions to continue the flight, but otherwise a powered sailplane is ideal to introduce new propulsion systems as safe flight is always possible without propulsion.
Response	Agreed: Requirement CS22.1553 reworded and AMC/GM added

Commentor	Alexander Schleicher GmbH & Co. Segelflugzeugbau
Paragraph	**CS 22.1553**
Comment	It should be made clear, that the term 'energy' is not to be understood in the physical manner. The indicator may inform the pilot in terms of kW, percent of capacity, or other suitable units. Justification We assume, that the authors of the Special Condition use the general term "energy" to describe a quantity that informs the pilot about the remaining capability of the power-plant. But this term may lead to the impression that a strict physical information in J or kWh is required. But this may suggest a higher precision, than can be provided, due to the amount of influencing factors (temperature, life time, power requested by pilot,..). Proposed Text, to be added The unit may be kWh, percent of capacity or any other suitable unit.
Response	Agreed: Requirement CS22.1553 reworded and AMC/GM added