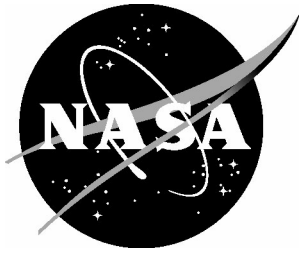


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# Assessment of Aircraft Electric Engine Regulatory Special Conditions

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July 2026

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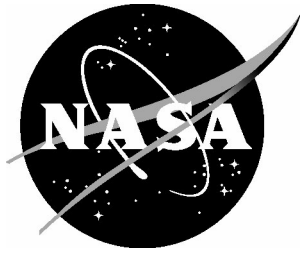
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# *EXECUTIVE SUMMARY*

This report provides a regulatory gap assessment of the Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency (EASA) Special Conditions (SC) for electric engines. This information is presented to support ongoing international harmonization efforts for electric engine certification, to establish a level of safety consistent across regulatory bodies and equivalent to that of existing combustion engines.

HS Advanced Concepts LLC assembled a team of subject-matter experts to develop a comprehensive comparison of the regulatory text of EASA SC E-19 and the FAA special conditions for the certification of electric engines. The team included Mr. Chris Baczynski of BAC Aerospace Inc. and Mr. Zach Kaufman, formerly with magniX.



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# 1. Introduction

## 1.1. Purpose

This report provides a regulatory gap assessment of the special conditions for electric engines issued by the Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency (EASA). This information is presented for inclusion in ongoing international harmonization efforts for electric engine certification to establish a consistent level of safety across regulatory bodies, equivalent to that of existing combustion engines.

## 1.2. Background

Civil aviation authorities issue special conditions when it is found that the airworthiness regulations for an aircraft, aircraft engine, or propeller design do not contain adequate or appropriate safety standards because of a novel or unusual design feature. EASA and the FAA have divergent approaches to issuing special conditions for electric engines. EASA has published a generic special condition, SC E-19, whereas the FAA publishes individual special conditions for individual applicants. The FAA began work on special conditions for electric engines in 2019 and issued the first electric engine special condition, 33-022-SC, to magniX in 2021<sup>1</sup>. Subsequent special conditions have been issued to other applicants with some refinement; however, applicant-specific special conditions have converged with the issuance of Special Conditions (SC) to Beta<sup>2</sup> (33-028-SC), Safran<sup>3</sup> (33-23-01-SC), the engine portions of Joby<sup>4</sup> and Archer<sup>5</sup> special conditions, as well as the engine portion to recently released Advisory Circular 21.17-4. It should also be noted that EASA's SC E-19 is issued for Electric Hybrid Propulsion Systems (EHPS), which includes electric engines but is broader, encompassing hybrid architectures and propulsion battery systems. The online references to these documents are found in Table 1.

*Table 1 - Online References to the Current Engine Regulations and the Special Conditions*

| Document                                                                                                          | Online Reference                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14 CFR Part 33, Aircraft Engines                                                                                  | <a href="https://www.ecfr.gov/current/title-14/chapter-I/subchapter-C/part-33">https://www.ecfr.gov/current/title-14/chapter-I/subchapter-C/part-33</a>                                                                                                                                                                                               |
| EASA CS-E                                                                                                         | <a href="https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-engines-cs-e">https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-engines-cs-e</a>                                                                                                                                         |
| SC E-19                                                                                                           | <a href="https://www.easa.europa.eu/en/special-condition-sc-e-19-electric-hybrid-propulsion-system">https://www.easa.europa.eu/en/special-condition-sc-e-19-electric-hybrid-propulsion-system</a>                                                                                                                                                     |
| Special Conditions magniX USA, Inc., magni350 and magni650 Model Engines; Electric Engine Airworthiness Standards | <a href="https://www.federalregister.gov/documents/2021/09/27/2021-19926/special-conditions-magnix-usa-inc-magni350-and-magni650-model-engines-electric-engine-airworthiness">https://www.federalregister.gov/documents/2021/09/27/2021-19926/special-conditions-magnix-usa-inc-magni350-and-magni650-model-engines-electric-engine-airworthiness</a> |
| Special Conditions to Beta                                                                                        | <a href="https://www.federalregister.gov/documents/2024/12/17/2024-29490/special-conditions-beta-technologies-inc-model-h500a-electric-engines">https://www.federalregister.gov/documents/2024/12/17/2024-29490/special-conditions-beta-technologies-inc-model-h500a-electric-engines</a>                                                             |

<sup>1</sup> The FAA's Special Condition 33-022-SC, effective October 27, 2021, establishes airworthiness standards for magniX USA, Inc. models magni350 and magni650. These conditions address safety for electric engines—which lack existing regulations—using ASTM F3338-18 standards. Key requirements cover insulation, high-voltage systems, fire protection, and software/firmware integrity.

<sup>2</sup> Beta Technologies, Inc.

<sup>3</sup> Safran S.A.

<sup>4</sup> Joby Aviation

<sup>5</sup> Archer Aviation Inc.

| Document                                                                          | Online Reference                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Special Conditions for the Safran ENGINEUS (ENGINE US100) series electric engines | <a href="https://www.federalregister.gov/documents/2026/01/27/2026-01642/special-conditions-safran-electric-and-power-sa-enginetm-us100-series-electric-engines">https://www.federalregister.gov/documents/2026/01/27/2026-01642/special-conditions-safran-electric-and-power-sa-enginetm-us100-series-electric-engines</a>                         |
| Special Conditions for the Joby JS4                                               | <a href="https://www.federalregister.gov/documents/2022/11/08/2022-23962/airworthiness-criteria-special-class-airworthiness-criteria-for-the-joby-aero-inc-model-jas4-1">https://www.federalregister.gov/documents/2022/11/08/2022-23962/airworthiness-criteria-special-class-airworthiness-criteria-for-the-joby-aero-inc-model-jas4-1</a>         |
| Special Conditions for Archer                                                     | <a href="https://www.federalregister.gov/documents/2024/05/24/2024-11192/airworthiness-criteria-special-class-airworthiness-criteria-for-the-archer-aviation-inc-model-m001">https://www.federalregister.gov/documents/2024/05/24/2024-11192/airworthiness-criteria-special-class-airworthiness-criteria-for-the-archer-aviation-inc-model-m001</a> |

### 1.3. Scope

This assessment compares published Special Conditions for both FAA (ref. magniX Special Condition 33-022-SC, Beta Special Condition 33-028-SC, and subsequent product-specific special conditions for Safran and subpart H of special conditions for Joby and Archer) vis-à-vis EASA (SC E-19) in the context of electric engines only. This assessment does not consider electric-hybrid engine systems, propulsion battery systems, or any additional scope included in EASA’s definition of EHPS, as defined in SC E-19; some requirements, such as EHPS.380, are omitted from this gap assessment. This paper does not discuss developing standards or means of compliance although the information contained herein may serve as foundations for the development of such references.

The assessment of regulatory requirements, in the form of special conditions, is independent of any specific design, application, or project. Considerations for individual applications are reserved for the discussion between an applicant and the Civil Aviation Authority.

## 2. Gap Assessment

The gap assessment is presented in a tabular format in Appendix A. The table identifies the special condition topic under the subject matter. The applicable special condition(s) for both FAA Special Conditions and EASA SC E-19 are then presented in their respective columns. A final column, labeled *Assessment*, provides an assessment of the textual differences between the FAA and EASA special conditions and identifies gaps where they may exist.

The baseline FAA Special Condition used for comparison with EASA’s SC E-19 is 33-028-SC, which was issued to Beta Technologies. This text incorporates clarifying changes to the FAA Special Conditions issued to magniX (33-022-SC). The presented FAA SC, 33-028-SC, is supplemented with text from 33-022-SC for variable pitch propeller (SC31), which does not apply to Beta Technologies’ design.

There are 31 categories that are reflected in the detailed gap analysis in Appendix A. These are: Applicability, Ratings, Materials, Fire, Durability, Cooling, Attachments, Overspeed, Engine Control System, Instrument, Stress, Critical Parts, Lubrication, Power Response, Continued Rotation, Safety, Ingestion, Liquid, Vibration, Overtorque, Calibration, Endurance, Temperature, Operation, System & Components, Rotor Locking, Teardown, Containment, Variable Pitch, Conduct of tests, and Engine Electrical System.

Each of these 31 categories was reviewed for key differences and to provide insights into those differences.

### 3. Conclusion

The gap analysis provided above considers only the textual differences in the special conditions and makes no assumptions about possible interpretations of the rules. This highlights the following points:

1. There are textual differences between EASA and FAA special conditions for electric engines that may be significant.
2. The gaps between the special conditions are independent of any applicant's product, and
3. The identified regulatory gaps should be considered when developing means of compliance. These gaps, if unresolved, may provide challenges in developing a common means of compliance.

The authorities should consider the differences identified in the gap analysis to determine whether each difference represents an intentional divergence or is merely a matter of using different language to capture the same intent. This activity may be supplemented by each authority's respective interpretation and expectations for establishing a sufficient level of safety for electric engines.



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APPENDIX A    DETAILS OF GENERAL GAP ASSESSMENT

| Description   | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Applicability | <p>1. Applicability</p> <p>(a) Unless otherwise noted in these special conditions, the engine design must comply with the airworthiness standards for aircraft engines set forth in part 33, except for those airworthiness standards that are specifically and explicitly applicable only to reciprocating and turbine aircraft engines or as specified herein.</p> <p>(b) The applicant must comply with this part using a means of compliance, which may include consensus standards, accepted by the Administrator.</p> <p>(c) The applicant requesting acceptance of a means of compliance must provide the means of compliance to the FAA in a form and manner acceptable to the Administrator.</p>                                                      | <p>EHPS.10 Scope</p> <p>The purpose of this special conditions is to provide the certification requirements for an Electric and / or Hybrid Propulsion System when the intended aircraft application has already been identified.</p> <p>This Special Condition is applicable to any Electric / Hybrid Propulsion System, so called hereafter EHPS, which is used to provide or produce lift/thrust/power for flight in a manned and unmanned aircraft, during both normal and emergency operations, except for CS-22, CS-LSA, CS-23 Level 1 Day VFR and Light UAS. It should be noted that for CS-25 aircraft, this Special Condition shall be complemented with appropriate emissions requirements that are yet to be defined for EHPS.</p> <p>Even if the EHPS contributes to the lift production in some intended aircraft applications like VTOL, the function of control of the lift to ensure the aircraft sustentation, control and manoeuvrability, is an aircraft function and it should be covered by the intended aircraft application certification basis.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>Key differences:</p> <ul style="list-style-type: none"><li>- FAA SC is for electric engines vs EASA SC for EHPS, which may involve a different perimeter and scope (e.g. hybrid, batteries, etc.).</li><li>- FAA SC is product-specific (though wording nearly identical) vs EASA SC is of general applicability.</li><li>- EASA SC constrains the applicant by wording "the intended aircraft application has already been identified"; no such constraint in the FAA version</li><li>- FAA SC imposes FAR 33 Subparts A and B as applicable + additional SC content. I.e. FAR 33.1 through 33.29 remain applicable, with additions as specified by the FAA SC.</li></ul>                                                                                                                                                                                                                                                                                   |
| Ratings       | <p>2. Engine Ratings and Operating Limits</p> <p>In addition to § 33.7(a), the engine ratings and operating limits must be established and included in the type certificate data sheet based on:</p> <p>(a) Shaft power, torque, rotational speed, and temperature for:</p> <p>(1) Rated takeoff power;</p> <p>(2) Rated maximum continuous power; and</p> <p>(3) Rated maximum temporary power and associated time limit.</p> <p>(b) Duty cycle and the rating at that duty cycle. The duty cycle must be declared in the engine type certificate data sheet.</p> <p>(c) Cooling fluid grade or specification.</p> <p>(d) Power-supply requirements.</p> <p>(e) Any other ratings or limitations that are necessary for the safe operation of the engine.</p> | <p>EHPS.40 Ratings and operating limitations</p> <p>(a) Ratings and operating limitations must be established, including ratings and limitations based on the operating conditions and information specified in this paragraph, and any other information that is necessary for safe operation of the EHPS. Ratings and operating limitations must be approved by the Agency.</p> <p>(b) The EHPS operating limitations include any limitation to ensure the safe operation of the EHPS and its associated sub-systems.</p> <p>(c) Ratings must be established for Take-off Power and/or Thrust and for Maximum Continuous Power and/or Thrust, as well as for Emergency Ratings if Emergency Ratings are intended to be used.</p> <p>(d) The Maximum permitted duration for the use of ratings other than Maximum Continuous Power and/or Thrust Rating must be established.</p> <p>(e) When requested by the Applicant, other ratings, associated with the maximum permitted duration for the use of each of these ratings, may also be established.</p> <p>(f) Emergency rating(s) must be established separately from the other ratings, and the specific failures associated with each emergency rating must be defined.</p> <p>(g) Each selected rating must be for the lowest thrust, lift or power that all affected sub-systems of the EHPS of the same type are capable of producing under the conditions used to determine that rating at all times during the flight and at all times between overhaul periods or other maintenance.</p> <p>(h) Each Normal transient EHPS exceedance (amplitude and duration) must be established.</p> | <p>EASA SC 1(f) wording related to emergency ratings and the specific failures has no equivalent in the FAA SC. More importantly, EHPS.15 is missing from this table. EHPS.15 defines emergency rating as:</p> <p><i>Means a rating intended to be used in the event of a failure leading to a power, thrust or lift loss of a sub-system of the EHPS and requiring the remaining sub-systems of the EHPS to compensate fully or partially the associated power and/or thrust loss.</i></p> <p><i>A rating is defined for all the sub-systems of the EHPS providing thrust, lift or power to a device that provides thrust or lift, such as a propeller or a rotor.</i></p> <p>With the above definition: if an electric engine loses, say, 10% of its power (i.e., minor power loss), and the design compensates to fully regain its power, an emergency rating would be required. Suggest to clarify this with EASA to harmonize the intent with the FAA.</p> |

| Description | FAA Electric SC                                                  | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Assessment                                                                                                                                                                                                                                                                                                              |
|-------------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Materials   | 3. Materials<br>The engine design must comply with 14 CFR 33.15. | <p>EHPS.50 Materials</p> <p>(a) The suitability and durability of materials used in the EHPS must be established for the intended design conditions of the system. The design values of the relevant properties of materials must be suitably related to the minimum properties stated in the material specification. The design values of the relevant properties of materials must meet or exceed the properties assumed in the design data over the life time of the EHPS.</p> <p>(b) Manufacturing methods and processes must be such as to produce sound structure and mechanisms, and electrical systems that retain the design properties under assumed service conditions. This includes the effects of deterioration over time, e.g. corrosion, insulation break-down</p> | EHPS.50(b) does not have a direct equivalent in FAR 33.15; specifically the provisions for electrical systems retaining their design properties and accounting for the deterioration over time are not explicit in SC 3/33.15 and could be missed. This was partially rectified by the FAA in SC33 for Beta and Safran. |

| Description | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fire        | <p>4. Fire Protection</p> <p>The engine design must comply with § 33.17(b) through (g). In addition—</p> <p>(a) The design and construction of the engine and the materials used must minimize the probability of the occurrence and spread of fire during normal operation and failure conditions and must minimize the effect of such a fire.</p> <p>(b) High-voltage electrical wiring interconnect systems must be protected against arc faults that can lead to hazardous engine effects as defined in special condition no. 17(d)(2) of these special conditions. Any non-protected electrical wiring interconnects must be analyzed to show that arc faults do not cause a hazardous engine effect.</p> <p>§ 33.17 Fire protection.</p> <p>(b) Except as provided in paragraph (c) of this section, each external line, fitting, and other component, which contains or conveys flammable fluid during normal engine operation, must be fire resistant or fireproof, as determined by the Administrator. Components must be shielded or located to safeguard against the ignition of leaking flammable fluid.</p> <p>(c) A tank, which contains flammable fluids and any associated shut-off means and supports, which are part of and attached to the engine, must be fireproof either by construction or by protection unless damage by fire will not cause leakage or spillage of a hazardous quantity of flammable fluid. For a reciprocating engine having an integral oil sump of less than 23.7 liters capacity, the oil sump need not be fireproof or enclosed by a fireproof shield.</p> <p>(d) An engine component designed, constructed, and installed to act as a firewall must be:</p> <p>(1) Fireproof;</p> <p>(2) Constructed so that no hazardous quantity of air, fluid or flame can pass around or through the firewall; and,</p> <p>(3) Protected against corrosion;</p> <p>(e) In addition to the requirements of paragraphs (a) and (b) of this section, engine control system components that are located in a designated fire zone must be fire resistant or fireproof, as determined by the Administrator.</p> <p>(f) Unintentional accumulation of hazardous quantities of flammable fluid within the engine must be prevented by draining and venting.</p> <p>(g) Any components, modules, or equipment, which are susceptible to or are potential sources of static discharges or electrical fault currents must be designed and constructed to be properly grounded to the engine reference, to minimize the risk of ignition in external areas where flammable fluids or vapors could be present.</p> | <p>EHPS.100 Fire Protection</p> <p>(a) The design and construction of the EHPS and the materials used must minimise the probability of the occurrence and spread of fire during normal operation and EHPS failure conditions and must minimize the effect of such a fire.</p> <p>(b) In addition, the design and construction of the EHPS must minimise the probability of the occurrence of an internal fire that could result in structural Failure or Hazardous EHPS Failure.</p> <p>EHPS.350 EHPS Control System</p> <p>(e) EHPS control system failures.</p> <p>The EHPS control system must:</p> <p>(3) Be designed and constructed so that foreseeable Failures or malfunctions leading to local events in the intended aircraft application, such as fire, overheat, electrical arcing or Failure leading to damage to EHPS Control System components, must not result in a Hazardous EHPS Effect or Catastrophic Aircraft Effect due to EHPS Control System Failures or malfunctions.</p> <p>EHPS.370 Electrical power generation, distribution and wirings</p> <p>(a) The electrical power generation, distribution and wirings of the EHPS must be designed and constructed so as to meet the Type-Certification basis of the intended aircraft application.</p> | <p>EHPS.100(a) is equivalent FAA SC 4(a). Note that EHSP.100(a) is equivalent to CS-E 130(a), with EHPS.100(a) being equivalent to FAR 33.17(a), except for the "turbine specific text".</p> <p>Other than that, the differences are fundamental. EHPS.100 does NOT incorporate text equivalent to CS-E 130(b) through (g), while the FAA SC does incorporate FAR 33.17(b) through (g).</p> <p>This, if not addressed by other means, could have a major impact on electric engines utilizing flammable fluids AND on hybrid engines, as turbine (or piston) portions of hybrids do use flammable fluids.</p> <p>EHPS.350(e)(3) cited in the table is not directly equivalent to SC4 Fire Protection, but is closer in intent to SC10(f)(3) and (4).</p> <p>EHPS.370 cited in column C is not equivalent to SC4 Fire Protection, but is closer in intent to SC33 of Beta and Safran SCs</p> <p>Conclusion: significant differences (apart from sub-paragraphs (a)) and the lack of specific coverage in the EASA SC for applications that do use flammable fluids, may result in significant differences in interpretation and should be considered as a potential subject for CMT to harmonize on.</p> |

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| Description | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                     | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Durability  | 5. Durability<br>The engine design and construction must minimize the development of an unsafe condition of the engine between maintenance intervals, overhaul periods, or mandatory actions described in the applicable ICA.                                                                                                                                       | EHPS.430 Durability Demonstration<br>The EHPS must be subjected to a durability demonstration to show that each part of the EHPS has been designed and constructed to minimise the probability of failure of the system and sub-systems between overhaul periods, or between replacement intervals of EHPS components/parts. This substantiation must simulate the conditions in which the EHPS is expected to operate in service, including typical start-stop cycles and scheduled maintenance actions and must be of a sufficient duration in order to provide confidence in the durability of the EHPS                         | In the FAA version, there are two separate provisions: SC5, which is a design requirements, and SC 26 which is a test requirement. EASA SC uses a single provision, EHPS.430 with text equivalent only to the latter (SC26), except that: FAA wording is clear on the word "test"; see last sentence of SC26. The EASA SC uses the word "substantiation" which could mean MoC other than test.                                                                                                                                                                                                                                                           |
| Cooling     | 6. Engine Cooling<br>The engine design and construction must comply with § 33.21. In addition, if cooling is required to satisfy the safety analysis as described in special condition no. 17 of these special conditions, the cooling system monitoring features and usage must be documented and provided to the installer as part of the requirements in § 33.5. | EHPS.320 Cooling system<br>(a) The design and construction of the EHPS cooling system must ensure adequate cooling in all flight attitudes and atmospheric conditions in which the EHPS is expected to operate.<br><br>(b) Any reliance placed upon the assumed installed conditions or installation requirements must be declared in the instructions for installation as defined in EHPS.30.<br><br>(c) All approved coolants and additives must be declared in the instructions for installation and operation of the EHPS as defined in EHPS.30.                                                                               | Equivalent, but neither the FAA or EASA version addresses explicitly the blockage of cooling, even though:<br>- the FAA SC talks about blockage of cooling under SC17 (safety)<br>- EASA requires a demonstration<br>How to ensure a common understanding and application at the MoC level?                                                                                                                                                                                                                                                                                                                                                              |
| Attachments | 7. Engine-Mounting Attachments and Structure<br>The engine mounting attachments and related engine structures must comply with § 33.23.                                                                                                                                                                                                                             | EHPS.200 Static and fatigue Loads<br>(a) The loads induced by any part of the EHPS must be established and declared in the Instructions for installation and operation of the EHPS as stated in EHPS.30.<br><br>(b) The loads induced by the intended aircraft application, provided by the manufacturer of the intended aircraft application, must be declared in the Instructions for installation and operation of the EHPS as stated in EHPS.30.<br><br>(c) Each sub-system of the EHPS must be designed and constructed so that it will function properly under all loading conditions determined under EHPS.200 (a) and (b). | This is a difference.<br><br>EHPS.200(a)(b) are similar to 14 CFR 33.23(a).<br><br>EHPS.200(c) is a significant difference to 14 CFR 33.23(b). First, EHPS.200(c) is written as a design and construction requirement (design review) whereas 14 CFR 33.23(b) requires demonstration (test or analysis on the basis of test). Further, the acceptance criteria for 14 CFR 33.23(b) prescribes that the engine supports a limit load without deformation and an ultimate load without failure. EHPS.200 states that the EHPS will function properly under loading conditions which could be a different outcome than those prescribed in 14 CFR 33.23(b). |

| Description           | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| Attachments           | 8. Accessory Attachments<br>The engine must comply with 14 CFR 33.25.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | EHPS.330 Equipment<br>(a) Mountings and drives for all equipment to be installed on the EHPS sub-systems must be designed to permit safe operation of the EHPS with the equipment fitted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>There is a minor difference.</p> <p>EHPS.330 does not require that accessories are accessible for inspection, adjustment, or removal. This could lead to EHPS-compliant engines having unserviceable accessories that would not be permitted within the FAA system.</p> <p>The following text of FAR 33.25 is missing from the EASA SC:</p> <p>[Each engine accessory drive and mounting attachment must include provisions for sealing to prevent contamination of, or unacceptable leakage from, the engine interior. A drive and mounting attachment requiring lubrication for external drive splines, or coupling by engine oil, must include provisions for sealing to prevent unacceptable loss of oil and to prevent contamination from sources outside the chamber enclosing the drive connection. The design of the engine must allow for the examination, adjustment, or removal of each accessory required for engine operation.]</p> |
| Overspeed             | 9. Overspeed<br>(a) A rotor overspeed must not result in a burst, rotor growth, or damage that results in a hazardous engine effect, as defined in Special Condition no.17(d)(2). Compliance with this paragraph must be shown by test, validated analysis, or a combination of both. Applicable assumed rotor speeds must be declared and justified.<br>(b) Rotors must possess sufficient strength with a margin to burst above certified operating conditions and above failure conditions leading to rotor overspeed. The margin to burst must be shown by test, validated analysis, or a combination thereof.<br>(c) The engine must not exceed the rotor speed operational limitations that could affect rotor structural integrity. | <p>EHPS.240 Overspeed and Rotor Integrity</p> <p>(a) A rotor overspeed must not result in either rotor burst, rotor growth or other damage that could result in a Hazardous EHPS effect. This must be shown by test, validated analysis, or a combination of both. Applicable assumed speeds must be declared and justified. Failure conditions shall be taken into account, including loss of load.</p> <p>(b) Rotors must be shown to provide adequate strength margin with respect to burst, growth and damages, that could result in a Hazardous EHPS effect, above the certified operating conditions and speeds assumed in EHPS.240 (a).</p> <p>EHPS.350 EHPS Control System</p> <p>(a) The EHPS control system must be designed such that:</p> <p>(1) the EHPS does not experience any unacceptable operating characteristics (including unacceptable power oscillations) or exceed any of its operating limitations</p> | <p>The EASA SC explicitly requires that loss of load condition is considered.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Engine Control System | 10. Engine Control Systems<br>(a) Applicability.<br>The requirements of this special condition apply to any system or device that is part of the engine type design, that controls, limits, monitors, or protects engine operation and is necessary for the continued airworthiness of the engine.                                                                                                                                                                                                                                                                                                                                                                                                                                         | 10. Engine Control Systems<br>(a) Applicability.<br>The requirements of this special condition apply to any system or device that is part of the engine type design, that controls, limits, monitors, or protects engine operation and is necessary for the continued airworthiness of the engine.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Equivalent requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Engine Control System | (b) Engine control.<br>The engine control system must ensure the engine does not experience any unacceptable operating characteristics or exceed its operating limits, including in failure conditions where the fault or failure results in a change from one control mode to another, from one channel to another, or from the primary system to the back-up system, if applicable.                                                                                                                                                                                                                                                                                                                                                      | EHPS.350 EHPS Control System<br>(a) The EHPS control system must be designed such that: <p>(1) the EHPS does not experience any unacceptable operating characteristics (including unacceptable power oscillations) or exceed any of its operating limitations</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Equivalent requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Description           | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| Engine Control System | (c) Design Assurance.<br>The software and complex electronic hardware, including programmable logic devices, must be—<br>(1) Designed and developed using a structured and systematic approach that provides a level of assurance for the logic commensurate with the hazard associated with the failure or malfunction of the systems in which the devices are located; and<br>(2) Substantiated by a verification methodology acceptable to the Administrator.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | EHPS.350 EHPS Control System<br>(b) Development Assurance<br>Any software and Airborne Electronic Hardware, including programmable logic devices, must be designed and developed using a structured and methodical approach that provides a level of assurance, that is commensurate with the severity of the hazard associated with the failure or malfunction of the systems using this software or hardware, and is substantiated by a verification methodology acceptable to the Agency.<br>System aspects are addressed in EHPS.80 (a)(3).                                                                                                                                     | Equivalent requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Engine Control System | (d) Validation.<br>All functional aspects of the control system must be substantiated by test, analysis, or a combination thereof, to show that the engine control system performs the intended functions throughout the declared operational envelope.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | EHPS.350 EHPS Control System<br>(c) Validation<br>The EHPS control system must perform the intended functions in all flight attitudes and atmospheric conditions in which the EHPS is expected to operate.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Equivalent requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Engine Control System | (e) Environmental Limits.<br>Environmental limits that cannot be adequately substantiated by endurance demonstration, validated analysis, or a combination thereof must be demonstrated by the system and component tests in special condition no. 27 of these special conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | EHPS.490 System, equipment and component tests<br>For those systems and components that cannot be adequately substantiated in accordance with endurance tests, validated analysis, or a combination thereof, additional tests must be conducted to demonstrate that systems or components are able to perform their intended functions in all declared environmental and operating conditions.                                                                                                                                                                                                                                                                                      | Equivalent requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Engine Control System | (f) Engine control system failures.<br>The engine control system must—<br>(1) Have a maximum rate of loss of power control (LOPC) that is suitable for the intended aircraft application. The estimated LOPC rate must be documented and provided to the installer as part of the requirements in § 33.5;<br>(2) When in the full-up configuration, be single-fault tolerant, as determined by the Administrator, for electrical, electrically detectable, and electronic failures involving LOPC events;<br>(3) Not have any single failure that results in hazardous engine effects as defined in special condition no. 17(d)(2) of these special conditions; and<br>(4) Ensure failures or malfunctions that lead to local events in the aircraft do not result in hazardous engine effects, as defined in special condition no. 17(d)(2) of these special conditions, due to engine control system failures or malfunctions. | EHPS.350 EHPS Control System<br>(e) EHPS control system failures.<br>The EHPS control system must:<br>(1) Meet the safety objectives of the intended aircraft application;<br>(2) Not have any single failures that result in Hazardous EHPS Effect(s) or Catastrophic Aircraft Effect; and<br>(3) Be designed and constructed so that foreseeable Failures or malfunctions leading to local events in the intended aircraft application, such as fire, overheat, electrical arcing or Failure leading to damage to EHPS Control System components, must not result in a Hazardous EHPS Effect or Catastrophic Aircraft Effect due to EHPS Control System Failures or malfunctions. | FAA SC 10(f)(1) has explicit documentation requirements.<br><br>FAA SC 10(f)(2) explicitly adds the requirement for single fault tolerance for LOPC.<br><br>EHPS.350(e)(2) requires aircraft-level compliance as a condition of engine-level compliance, introducing the idea of CAT aircraft effects. Generally, engine effects that can cause CAT aircraft effects are limited to HAZ engine effects, however, MAJ engine effects paired with incorrect operating procedures at the aircraft level can result in CAT aircraft effects. EHPS.350 could introduce a different level of safety to the FAA SC.<br><br>Furthermore, the aircraft level FHA depends on the specific architecture of the propulsion system. For example, for a Part 25 airliner, unrecoverable shutdown of both engines would be considered CAT, while at an engine level, 33.75 would classify that as minor.<br><br>EHPS.350(e)(3) is written in such a way that may not require the applicant to demonstrate the capability and opens the door for complying with this requirement by design review, which is a different level of safety to the FAA SC. |

| Description           | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| Engine Control System | (g) System safety assessment.<br>The applicant must perform a system safety assessment. This assessment must identify faults or failures that affect normal operation, together with the predicted frequency of occurrence of these faults or failures. The intended aircraft application must be taken into account to assure that the assessment of the engine control system safety is valid. The rates of hazardous and major faults must be documented and provided to the installer as part of the requirements in § 33.5.                                                                                                                                                                                                                                                                                                                                                                                                                                   | EHPS.80 Safety Assessment<br>(a) (1) An analysis of the EHPS, including the control system, must be carried out in order to assess all Failure Conditions that can reasonably be expected to occur. This analysis must take account of:<br>(i) The intended aircraft application: the evaluation of the EHPS failures conditions and their effects must be made at aircraft level in coordination with the intended aircraft manufacturer who must establish the probability of occurrence of those failure conditions acceptable for the intended aircraft application. This evaluation of the EHPS failure conditions and associated failure rates must be detailed in the installation instructions as required in EHPS.30 (b)(7). Alternatively, this data must be established and provided in the safety assessment of the intended aircraft application if the EHPS is certified as part of the aircraft certification. | Difference in the implementation.<br><br>FAA SC requires that the intended aircraft application be taken into account. Elsewhere, these assumptions are required to be communicated to the installer.<br><br>EHPS.80, however, requires that the engine level effects be assessed at the aircraft level and requires bringing the aircraft manufacturer into the engine TC process. In addition, EHPS.80 caters for the possibility of the EHPS being certified as part of the aircraft, while the FAA SC does not.<br><br>FAA SC 10(g) has explicit documentation requirements. |
| Engine Control System | (h) Protection systems.<br>The engine control devices and systems' design and function, together with engine instruments, operating instructions, and maintenance instructions, must ensure that engine operating limits that can lead to a hazard will not be exceeded in service.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | EHPS.350 EHPS Control System<br>(a) The EHPS control system must be designed such that:<br>(1) the EHPS does not experience any unacceptable operating characteristics (including unacceptable power oscillations) or exceed any of its operating limitations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Difference in that the FAA requires that operating instructions and maintenance instructions are considered for compliance. EASA does not require communication of this specific information.                                                                                                                                                                                                                                                                                                                                                                                    |
| Engine Control System | (i) Aircraft supplied data.<br>Any single failure leading to loss, interruption, or corruption of aircraft-supplied data (other than power-command signals from the aircraft), or aircraft-supplied data shared between engine systems within a single engine or between fully independent engine systems, must—<br>(1) Not result in a hazardous engine effect, as defined in special condition no. 17(d)(2) of these special conditions, for any engine installed on the aircraft; and<br>(2) Be able to be detected and accommodated by the control system.                                                                                                                                                                                                                                                                                                                                                                                                     | Single failures leading to a loss, interruption or corruption of aircraft-supplied data, or aircraft-supplied data shared between independent EHPS or independent engines of an EHPS must:<br>(1) Not result in a Hazardous EHPS Effect or Catastrophic Aircraft Effect for any EHPS installed on the aircraft; and<br>(2) Be detected and accommodated. The accommodation strategy must not result in an unacceptable change in thrust, lift or power or an unacceptable change in the EHPS operating and starting characteristics. The effects of these Failures on EHPS thrust, lift or power, EHPS operability and starting characteristics throughout the flight envelope must be evaluated and documented as part of the Instructions for installation and operation of the EHPS as stated in EHPS.30.                                                                                                                  | See comment to SC 10(f) / EHPS.350(e)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Engine Control System | (j) Engine control system electrical power.<br>(1) The engine control system must be designed such that the loss, malfunction, or interruption of the control system electrical power source will not result in a hazardous engine effect, unacceptable transmission of erroneous data, or continued engine operation in the absence of the control function. Hazardous engine effects are defined in special condition no. 17(d)(2) of these special conditions. The engine control system must be capable of resuming normal operation when aircraft-supplied power returns to within the declared limits.<br>(2) The applicant must identify, document, and provide to the installer as part of the requirements in § 33.5, the characteristics of any electrical power supplied from the aircraft to the engine control system, including transient and steady-state voltage limits, and any other characteristics necessary for safe operation of the engine. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Additional requirement from the FAA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

| Description    | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| Instrument     | <p>(11) Instrument Connection<br/>The applicant must comply with § 33.29(a), (e), and (g).<br/>(a) In addition, as part of the system safety assessment of special condition nos. 10(g) and 33(h) of these special conditions, the applicant must assess the possibility and subsequent effect of incorrect fit of instruments, sensors, or connectors. Where practicable, the applicant must take design precautions to prevent incorrect configuration of the system.<br/>(b) The applicant must provide instrumentation enabling the flight crew to monitor the functioning of the engine cooling system unless evidence shows that:<br/>(1) Other existing instrumentation provides adequate warning of failure or impending failure;<br/>(2) Failure of the cooling system would not lead to hazardous engine effects before detection; or<br/>(3) The probability of failure of the cooling system is extremely remote.</p>                                                                                                                                                                                   | <p>EHPS.360 Aircraft instruments<br/>(a) As defined in EHPS.80, the EHPS parameters to be displayed on the aircraft instruments required to ensure the safe operation of the EHPS must be established as part of the safety assessment process.<br/><br/>(b) Provisions must be made for the installation of the instruments established in EHPS.360 (a).<br/><br/>(c) Any reliance placed upon the assumed installation and operation must be declared in the instructions for installation and operation of the EHPS as defined in EHPS.30.</p> | <p>EHPS.360 does not have a commensurate requirement to 14 CFR 33.29(a) and SC 11(a). As such, EASA-certified designs may not be compliant with 33.29(a) and SC 11(a) and would need to be redesigned to be compliant.<br/><br/>EHPS.360(a) only covers instruments and indications established as part of the safety process whereas 14 CFR 33.29(e) considers those identified from other sources as well.<br/><br/>The FAA has explicit requirements in SC 11(b) that are not reflected in the EHPS.360 and therefore may have a different level of safety.</p> |
| Stress         | <p>(12) Stress Analysis<br/>(a) A mechanical and thermal stress analysis, as well as an analysis of the stress caused by electromagnetic forces, must show a sufficient design margin to prevent unacceptable operating characteristics and hazardous engine effects as defined in special condition no. 17(d)(2) of these special conditions.<br/>(b) Maximum stresses in the engine must be determined by test, validated analysis, or a combination thereof, and must be shown not to exceed minimum material properties.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>EHPS.210 Strength<br/>(a) A mechanical, thermal and electrical stress analysis must show that there is suitable EHPS design margin at the declared operating limits. The suitable design margin must be established in the means of compliance.<br/><br/>(b) The maximum stresses in the EHPS must be determined by tests, validated analysis, or a combination thereof, and must be shown not to exceed minimum material properties defined in EHPS.50.</p>                                                                                   | <p>FAA special conditions explicitly require analysis of stresses caused by electromagnetic forces. EASA special condition requires analysis of electrical stresses as well. The FAA criteria is against hazardous engine effects whereas the EASA comparison is with respect to operating limits.</p>                                                                                                                                                                                                                                                             |
| Critical Parts | <p>(13) Critical and Life-Limited Parts<br/>(a) The applicant must show, by a safety analysis or means acceptable to the Administrator, whether rotating or moving components, bearings, shafts, static parts, and non-redundant mount components should be classified, designed, manufactured, and managed throughout their service life as critical or life-limited parts.<br/>(1) Critical part means a part that must meet prescribed integrity specifications to avoid its primary failure, which is likely to result in a hazardous engine effect as defined in special condition no. 17(d)(2) of these special conditions.<br/>(2) Life-limited parts may include but are not limited to a rotor or major structural static part, the failure of which can result in a hazardous engine effect, as defined in special condition no. 17(d)(2) of these special conditions, due to a low-cycle fatigue (LCF) mechanism. A life limit is an operational limitation that specifies the maximum allowable number of flight cycles that a part can endure before the applicant must remove it from the engine.</p> | <p>EHPS.80 Safety Assessment<br/>(b) If the Primary Failure of certain single elements that are likely to result in Hazardous EHPS Effects cannot be sensibly estimated in numerical terms, reliance must be placed on meeting the prescribed integrity specifications of EHPS.90. These instances must be stated in the safety analysis as required in (a)(2).</p>                                                                                                                                                                               | <p>Significant difference: FAA defines critical parts under SC13(a) and separately, life-limited parts under SC13(b). Both critical and life limited parts are defined irrespective of the ability to estimate their failure rates in numerical terms.</p>                                                                                                                                                                                                                                                                                                         |

| Description    | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                |
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| Critical Parts | <p>(b) In establishing the integrity of each critical part or life-limited part, the applicant must provide to the Administrator the following three plans for approval:</p> <p>(1) an engineering plan, as defined in § 33.70(a);</p> <p>(2) a manufacturing plan, as defined in § 33.70(b); and</p> <p>(3) a service-management plan, as defined in § 33.70(c).</p> <p>14 CFR 33.70:</p> <p>(a) An engineering plan that contains the steps required to ensure each engine life-limited part is withdrawn from service at an approved life before hazardous engine effects can occur. These steps include validated analysis, test, or service experience which ensures that the combination of loads, material properties, environmental influences and operating conditions, including the effects of other engine parts influencing these parameters, are sufficiently well known and predictable so that the operating limitations can be established and maintained for each engine life-limited part. Applicants must perform appropriate damage tolerance assessments to address the potential for failure from material, manufacturing, and service induced anomalies within the approved life of the part. Applicants must publish a list of the life-limited engine parts and the approved life for each part in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness as required by Sec. 33.4 of this part.</p> <p>(b) A manufacturing plan that identifies the specific manufacturing constraints necessary to consistently produce each engine life-limited part with the attributes required by the engineering plan.</p> <p>(c) A service management plan that defines in-service processes for maintenance and the limitations to repair for each engine life-limited part that will maintain attributes consistent with those required by the engineering plan. These processes and limitations will become part of the Instructions for Continued Airworthiness.</p> | <p>EHPS.90 EHPS Critical Parts</p> <p>The integrity of the EHPS Critical Parts identified under EHPS.80 must be established by:</p> <p>(a) An Engineering Plan, the execution of which establishes and maintains that the combinations of loads, material properties, environmental influences and operating conditions, including the effects of parts influencing these parameters, are sufficiently well known or predictable, by validated analysis, test or service experience, to allow each EHPS Critical Part to be withdrawn from service at an Approved Life before Hazardous EHPS Effects can occur. Appropriate Damage Tolerance assessments must be performed to address the potential for Failure from material, manufacturing and service-induced anomalies within the Approved Life of the part. The Approved Life must be published as required in EHPS.25.</p> <p>(b) A Manufacturing Plan which identifies the specific manufacturing constraints necessary to consistently produce EHPS Critical Parts with the Attributes required by the Engineering Plan.</p> <p>(c) A Service Management Plan which defines in-service processes for maintenance and repair of EHPS Critical Parts which will maintain Attributes consistent with those required by the Engineering Plan. These processes must become part of the instructions for continued airworthiness.</p> | <p>Significant difference: FAA defines critical parts under SC13(a)(1) and separately, life-limited parts under SC13(a)(2). Both critical and life limited parts are defined irrespective of the ability to estimate their failure rates in numerical terms.</p> <p>FAA specifies scope (pre and post-cert activity) and states requires a reporting system to capture issues.</p> <p>EHPS.90 does not explicitly specify this scope.</p> |

| Description        | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| Lubrication        | <p>14. Lubrication System</p> <p>(a) The lubrication system must be designed and constructed to function properly between scheduled maintenance intervals in all flight attitudes and atmospheric conditions in which the engine is expected to operate.</p> <p>(b) The lubrication system must be designed to prevent contamination of the engine bearings and lubrication system components.</p> <p>(c) The applicant must demonstrate by test, validated analysis, or a combination thereof, the unique lubrication attributes and functional capability of (a) and (b).</p>                         | <p>EHPS.310 Lubrication system</p> <p>(a) Any lubrication system of the EHPS must be designed and constructed so as to ensure the proper functioning of the EHPS in all flight attitudes and atmospheric conditions in which the EHPS is expected to operate, including negative g.</p> <p>(b) All parts of the lubrication system that are not inherently capable of being tolerant to contaminants likely to be present in the lubricant or otherwise introduced into the lubrication system must be suitably protected so as to preclude damage to the EHPS and EHPS equipment and have adequate capacity to tolerate contaminants in relation to the specified servicing intervals.</p> <p>(c) Any reliance placed upon the assumed installed conditions or installation requirements must be declared in the instructions for installation as defined in EHPS.30.</p> <p>(d) All approved lubricants and additives must be declared in the instructions for installation and operation of the EHPS as defined in EHPS.30.</p> | <p>EASA version explicitly includes a reference to negative G conditions (which the FAA does not), but has not reference to the time limits or the intended aircraft applications. Note for traditional turboprops, aircraft level compliance testing to FAR 23.943 is most often time limited by the ability of the engine to function with oil pressure near zero.</p> <p>FAA requires test or validated analysis to show compliance. Wording of EHPS.310 may allow for design review in lieu of test or validated analysis.</p> <p>EHPS.310(c)(d) are covered by FAA SC 19.</p> |
| Power Response     | <p>(15) Power Response</p> <p>(a) The design and construction of the engine, including its control system, must enable an increase—</p> <p>(1) From the minimum power setting to the highest rated power without detrimental engine effects;</p> <p>(2) From the minimum obtainable power while in-flight and while on the ground to the highest rated power within a time interval determined to be appropriate for the intended aircraft application; and</p> <p>(3) From the minimum torque to the highest rated torque without detrimental engine effects in the intended aircraft application.</p> | <p>EHPS.460 Operational Demonstration</p> <p>(c) Power Response</p> <p>The design and construction of the EHPS must allow the EHPS to provide a power response that is suitable for the safe operation of intended aircraft application.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>This is a notable difference as EHPS.460 may allow for demonstrations that would not meet FAA SC 15. If EHPS.460 is complied with in a manner that does not follow SC15(a), the applicant may not be able to validate their EHPS with the FAA. This should be addressed at the MoC level.</p>                                                                                                                                                                                                                                                                                   |
| Power Response     | <p>(b) The results of (a)(1), (a)(2), and (a)(3) of this special condition must be documented and provided to the installer as part of the requirements in § 33.5.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>Difference, no SC E-19 documentation requirement</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Continued Rotation | <p>(16) Continued Rotation</p> <p>If the design allows any of the engine main rotating systems to continue to rotate after the engine is shut down while in-flight, this continued rotation must not result in any hazardous engine effects, as defined in special condition no. 17(d)(2) of these special conditions.</p>                                                                                                                                                                                                                                                                              | <p>EHPS.260 Continued Rotation</p> <p>If any of the EHPS main rotating systems continue to rotate after the EHPS is shutdown while in flight, this continued rotation must be considered in the safety assessment in EHPS.80 and must not result in effects that would be unacceptable.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p>Difference as FAA SC 17 would allow continued rotation that could result in an effect that is less than a hazardous engine effect whereas EHPS.260 could prohibit that operation based on the provided language.</p>                                                                                                                                                                                                                                                                                                                                                            |

| Description | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Assessment                                                                                                                                                                                                                           |
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| Safety      | <p>(17) Safety Analysis</p> <p>(a) The applicant must comply with § 33.75(a)(1) and (a)(2) using the failure definitions in special condition no. 17(d) of these special conditions.</p> <p>§ 33.75 Safety analysis.</p> <p>(a)</p> <p>(1) The applicant must analyze the engine, including the control system, to assess the likely consequences of all failures that can reasonably be expected to occur. This analysis will take into account, if applicable:</p> <p>(i) Aircraft-level devices and procedures assumed to be associated with a typical installation. Such assumptions must be stated in the analysis.</p> <p>(ii) Consequential secondary failures and latent failures.</p> <p>(iii) Multiple failures referred to in paragraph (d) of this section or that result in the hazardous engine effects defined in paragraph (g)(2) of this section.</p> <p>(2) The applicant must summarize those failures that could result in major engine effects or hazardous engine effects, as defined in paragraph (g) of this section, and estimate the probability of occurrence of those effects. Any engine part the failure of which could reasonably result in a hazardous engine effect must be clearly identified in this summary.</p> | <p>EHPS.80 Safety Assessment</p> <p>(a) (1) An analysis of the EHPS, including the control system, must be carried out in order to assess all Failure Conditions that can reasonably be expected to occur. This analysis must take account of:</p> <p>(i) The intended aircraft application: the evaluation of the EHPS failures conditions and their effects must be made at aircraft level in coordination with the intended aircraft manufacturer who must establish the probability of occurrence of those failure conditions acceptable for the intended aircraft application. This evaluation of the EHPS failure conditions and associated failure rates must be detailed in the installation instructions as required in EHPS.30 (b)(7). Alternatively, this data must be established and provided in the safety assessment of the intended aircraft application if the EHPS is certified as part of the aircraft certification.</p> <p>(ii) Aircraft-level devices and procedures that are assumed to be associated with the intended aircraft application. Such assumptions must be stated in the analysis, and detailed in the Installation Instructions as required in EHPS.30 (b)(3).</p> <p>(iii) Consequential secondary Failures and dormant Failures.</p> <p>(iv) Multiple Failures that result in the Hazardous EHPS Effects, Hazardous Aircraft Effects or Catastrophic Aircraft Effects defined in EHPS.15.</p> <p>(2) A summary must be made of those Failures Conditions that could result in Major Aircraft Effects, Hazardous EHPS Effects, Hazardous Aircraft Effects or Catastrophic Aircraft Effects together with an estimate of the probability of occurrence of those effects. Any EHPS critical part must be clearly identified in this summary</p> | <p>Potential significant difference. EHPS.80 uses the verbiage "intended aircraft application" not "intended aircraft application(s)". This could lead to needing a different engine type certificate (TC) for each application.</p> |
| Safety      | <p>(b) If the failure of such elements is likely to result in hazardous engine effects, then the applicant may show compliance by reliance on the prescribed integrity requirements such as § 33.15, Special Condition no. 9, Special Condition no. 13, or combinations thereof, as applicable. The failure of such elements and associated prescribed integrity requirements must be stated in the safety analysis</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <p>EHPS.80 Safety Assessment</p> <p>(b) If the Primary Failure of certain single elements that are likely to result in Hazardous EHPS Effects cannot be sensibly estimated in numerical terms, reliance must be placed on meeting the prescribed integrity specifications of EHPS.90. These instances must be stated in the safety analysis as required in (a)(2).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <p>No difference; Better comparison against Beta/Safran FAA special conditions that are more closely aligned with the EHPS.80 verbiage.</p>                                                                                          |

| Description | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Assessment                                                                                                                  |
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| Safety      | <p>(c) The applicant must comply with § 33.75(d) and (e) using the failure definitions in Special Condition no. 17(d) of these special conditions.</p> <p>§ 33.75</p> <p>(d) If reliance is placed on a safety system to prevent a failure from progressing to hazardous engine effects, the possibility of a safety system failure in combination with a basic engine failure must be included in the analysis. Such a safety system may include safety devices, instrumentation, early warning devices, maintenance checks, and other similar equipment or procedures. If items of a safety system are outside the control of the engine manufacturer, the assumptions of the safety analysis with respect to the reliability of these parts must be clearly stated in the analysis and identified in the installation instructions under § 33.5 of this part.</p> <p>(e) If the safety analysis depends on one or more of the following items, those items must be identified in the analysis and appropriately substantiated.</p> <p>(1) Maintenance actions being carried out at stated intervals. This includes the verification of the serviceability of items that could fail in a latent manner. When necessary to prevent hazardous engine effects, these maintenance actions and intervals must be published in the instructions for continued airworthiness required under § 33.4 of this part. Additionally, if errors in maintenance of the engine, including the control system, could lead to hazardous engine effects, the appropriate procedures must be included in the relevant engine manuals.</p> <p>(2) Verification of the satisfactory functioning of safety or other devices at pre-flight or other stated periods. The details of this satisfactory functioning must be published in the appropriate manual.</p> <p>(3) The provisions of specific instrumentation not otherwise required.</p> <p>(4) Flight crew actions to be specified in the operating instructions established under § 33.5.</p> | <p>EHPS.80 Safety assessment</p> <p>(c) If the acceptability of the safety analysis is dependent on one or more of the following items, they must be identified in the analysis and appropriately substantiated:</p> <p>(1) Maintenance actions being carried out at stated intervals. The maintenance intervals must be published in the Airworthiness Limitations section of the Instructions for Continued Airworthiness (refer to EHPS.25) when necessary for preventing the occurrence of:</p> <p>(i) Hazardous EHPS Effects at a probability in excess of the Extremely Remote probability defined in the associated Type-Certification basis of the intended aircraft application; or</p> <p>(ii) Hazardous and Catastrophic Aircraft Effects at probabilities in excess of the probabilities defined by the intended application manufacturer and declared in the installation manual as stated in EHPS.30.</p> <p>(2) If errors in maintenance of the EHPS, including the EHPS Control System, could lead to Hazardous EHPS Effects, Hazardous or Catastrophic Aircraft Effects, appropriate procedures must be included in the relevant EHPS manuals.</p> <p>(3) Verification of the satisfactory functioning of safety or other devices at pre-flight or other stated periods. The details of this verification must be published in the appropriate manual.</p> <p>(4) The provision of specific instrumentation not otherwise required.</p> <p>(5) Operating instructions. These instructions must be identified:</p> <p>(i) in the operating instructions manual after an appropriate evaluation at aircraft level in coordination with the aircraft manufacturer; or</p> <p>(ii) in the intended aircraft application operating manual if the EHPS is certified as part of the aircraft application.</p> | <p>Some nuanced difference as EHPS.80(c)(1)(ii) would require the intended application's data as part of the engine TC.</p> |
| Safety      | <p>(d) Unless otherwise approved by the Administrator, the following definitions apply to the engine effects when showing compliance with this condition:</p> <p>(1) A minor engine effect does not prohibit the engine from meeting its certificated performance requirements and the intended functions in a manner consistent with § 33.28(b)(1)(i), § 33.28(b)(1)(iii) and § 33.28(b)(1)(iv), and the engine complies with the operability requirements such as Special Condition no. 15 (Power response), Special Condition no. 25 (Operation demonstration), and Special Condition no. 31 (Operation with a variable pitch propeller), as appropriate.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>Difference. Not included in SC E-19</p>                                                                                  |

| Description | FAA Electric SC                                                                                                                                                                                                                                                                                                                                   | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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| Safety      | (2) The engine effects in § 33.75(g)(2) are hazardous engine effects with the addition of:<br>(i) Electrocution of the crew, passengers, operators, maintainers, or others; and<br>(ii) Blockage of cooling systems that could cause the engine effects described in § 33.75(g)(2) and special condition 17(d)(2)(i) of these special conditions. | EHPS.15 Terminology<br>Hazardous EHPS effect Means the effect of Hazardous EHPS failure condition. The following effects, as a minimum, must be regarded as Hazardous EHPS Effects, unless demonstrated to not be applicable for the intended aircraft application:<br>(i) Non-containment of high-energy debris (including the release of a propeller or an Aircraft Rotor by the EHPS);<br>(ii) Concentration of toxic products in the air of the cabin that is sufficient to incapacitate crew or passengers;<br>(iii) Significant thrust in the opposite direction to that commanded by the pilot;<br>(iv) Uncontrolled fire;<br>(v) Failure of the EHPS mounting system leading to inadvertent EHPS separation;<br>(vi) Complete inability to shutdown any sub-systems of the EHPS containing rotating parts;<br>(vii) Complete inability to isolate the components that could cause a hazard to the aircraft;<br>(viii) Serious or fatal human injury, caused by electrocution, arc flash, arc blast or excessive electromagnetic field. | Difference.<br><br>Beta/Safran FAA SC clarifies a hazardous engine effect related to blockage of cooling.<br><br>EHPS.15 opens up the considerations due to high voltage to more than the FAA’s electrocution.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Safety      | (3) Any other engine effect is a major engine effect.                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Difference. Not included in SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Safety      | (e) The intended aircraft application must be taken into account when performing the safety analysis.                                                                                                                                                                                                                                             | EHPS.80 Safety Assessment<br>(a) (3) It must be shown that the design and construction of the EHPS allows the intended aircraft application to meet the qualitative (including Development Assurance) and quantitative safety objectives defined in the type-certification basis of the intended aircraft application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Difference. EHPS.80 requires the TC basis of the intended application to be defined prior to compliance.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Safety      | (f) The results of the safety analysis, and the assumptions about the aircraft application used in the safety analysis, must be documented and provided to the installer as part of the requirements in § 33.5.                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Difference. Not included in SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Ingestion   | (18) Ingestion<br>(a) Rain, ice, and hail ingestion must not result in an abnormal operation such as shutdown, power loss, erratic operation, or power oscillations throughout the engine operating range.                                                                                                                                        | EHPS.270 Rain conditions<br>The EHPS must be designed and/or installed such that it is capable of satisfactory operation throughout its specified operating envelope when subject to sudden encounters with rain.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Difference. Wording of FAA SC requires demonstration whereas wording of EHPS.270 may allow for design review compliance.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Ingestion   | (b) Ingestion from other likely sources (birds, induction system ice, foreign objects—ice slabs) must not result in hazardous engine effects defined by special condition no. 17(d)(2) of these special conditions, or unacceptable power loss.                                                                                                   | EHPS.290 Bird, hail strike and impact of foreign matter<br>(a) The EHPS must be designed and/or installed so that any impact or ingestion of bird or hail, or other impact of foreign matter, that is likely to occur in any one flight will not cause any Hazardous EHPS Effect or Catastrophic Aircraft Effect as defined in EHPS.15.<br>(b) If defined in the Type-Certification Basis of the intended application, it must also be shown that the impacts defined in (a) will not preclude the continued safe flight and landing of the aircraft as a consequence of an unacceptable:<br>(1) loss of performance;<br>(2) deterioration of EHPS/Aircraft handling characteristics;<br>(3) exceedance of any EHPS operating limitation.                                                                                                                                                                                                                                                                                                      | Significant difference.<br><br>FAA SC defines the pass/fail criteria as no hazardous engine effects AND no unacceptable power loss (the specific values are not in the SC but are in the FARs or the ACs).<br><br>The EASA version ties this to the aircraft application, some of it may be debatable, i.e. What is (1) loss of performance, or how would an engine OEM determine (2) deterioration of aircraft handling characteristics.<br><br>Which set of criteria are more stringent? What if an EASA applicant meets the EASA’s aircraft criteria but does not meet the FAA engine-level expectations? Or vice versa? |

| Description | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                              | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Assessment                                                                                                                                                                                      |
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| Ingestion   | (c) If the design of the engine relies on features, attachments, or systems that the installer may supply, for the prevention of unacceptable power loss or hazardous engine effects, as defined in special condition no. 17(d)(2) of these special conditions, following potential ingestion, then the features, attachments, or systems must be documented and provided to the installer as part of the requirements in § 33.5.                                            | EHPS.30 Instructions for installation and operation of the EHPS<br>(b) When the EHPS is certified independently of the aircraft, the instructions must include at least the following:<br>(5) Where an EHPS relies on components which are not part of the EHPS, the interface conditions, reliability specifications and safety rationale for those components upon which the EHPS certification is based;                                                                                         | Difference. EHPS.30 would require reliability specifications and safety rationale for the equipment which is more than what is required by FAA SC. FAA SC also requires specific documentation. |
| Liquid      | (19) Liquid and Gas Systems<br>(a) Each system used for lubrication or cooling of engine components must be designed and constructed to function properly in all flight attitudes and atmospheric conditions in which the engine is expected to operate.                                                                                                                                                                                                                     | EHPS.310 Lubrication system<br>(a) Any lubrication system of the EHPS must be designed and constructed so as to ensure the proper functioning of the EHPS in all flight attitudes and atmospheric conditions in which the EHPS is expected to operate, including negative g.<br><br>EHPS.320 Cooling system<br>(a) The design and construction of the EHPS cooling system must ensure adequate cooling in all flight attitudes and atmospheric conditions in which the EHPS is expected to operate. | Difference. EHPS.30 would require reliability specifications and safety rationale for the equipment which is more than what is required by FAA SC. FAA SC also requires specific documentation. |
| Liquid      | (b) If a system used for lubrication or cooling of engine components is not self-contained, the interfaces to that system must be defined, documented and provided to the installer as part of the requirements in § 33.5.                                                                                                                                                                                                                                                   | EHPS.310 Lubrication system<br>(c) Any reliance placed upon the assumed installed conditions or installation requirements must be declared in the instructions for installation as defined in EHPS.30.<br><br>EHPS.320 Cooling system<br>(b) Any reliance placed upon the assumed installed conditions or installation requirements must be declared in the instructions for installation as defined in EHPS.30.                                                                                    | Equivalent requirements.                                                                                                                                                                        |
| Liquid      | (c) The applicant must establish by test, validated analysis, or a combination of both that all static parts subject to significant pressure loads will not:<br>(1) Exhibit permanent distortion beyond serviceable limits, or exhibit leakage that could create a hazardous condition when subjected to normal and maximum working pressure with margin;<br>(2) Exhibit fracture or burst when subjected to the greater of maximum possible pressures with margin.          | No equivalent requirement in SC E-19.                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Equivalent requirements.                                                                                                                                                                        |
| Liquid      | (d) Compliance with special condition no. 19(c) of these special conditions must take into account:<br>(1) The operating temperature of the part;<br>(2) Any other significant static loads in addition to pressure loads;<br>(3) Minimum properties representative of both the material and the processes used in the construction of the part; and<br>(4) Any adverse physical geometry conditions allowed by the type design, such as minimum material and minimum radii. | No equivalent requirement in SC E-19.                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Difference. No equivalent requirement in SC E-19                                                                                                                                                |

| Description | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Assessment                                                                                                                                                                                                                                                                       |
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| Liquid      | (e) Approved coolants and lubricants must be listed, documented, and provided to the installer as part of the requirements in § 33.5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <p>EHPS.310 Lubrication system<br/>(d) All approved lubricants and additives must be declared in the instructions for installation and operation of the EHPS as defined in EHPS.30</p> <p>EHPS.320 Cooling system<br/>(c) All approved coolants and additives must be declared in the instructions for installation and operation of the EHPS as defined in EHPS.30.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Equivalent requirements.                                                                                                                                                                                                                                                         |
| Vibration   | <p>(20) Vibration Demonstration<br/>(a) The engine must be designed and constructed to function throughout its normal operating range of rotor speeds and engine output power, including defined exceedances, without inducing excessive stress in any of the engine parts because of vibration and without imparting excessive vibration forces to the aircraft structure.<br/>(b) Each engine design must undergo a vibration survey to establish that the vibration characteristics of those components subject to induced vibration are acceptable throughout the declared flight envelope and engine operating range for the specific installation configuration. The possible sources of the induced vibration that the survey must assess are mechanical, aerodynamic, acoustical, internally induced electromagnetic, installation induced effects that can affect the engine vibration characteristics, and likely environmental effects. This survey must be shown by test, validated analysis, or a combination thereof.</p> | <p>EHPS.230 Vibration Survey<br/>(a) The EHPS must be designed and constructed to function throughout its normal operating range of rotor speeds and EHPS output power or thrust, including defined exceedances, without inducing excessive stress in all affected parts of the EHPS caused by vibration and without imparting excessive vibration forces to the aircraft structure.<br/>(b) The applicant must conduct a vibration survey of the EHPS to establish that the vibration characteristics of those components that may be subject to mechanically induced vibrations, aerodynamically induced vibrations, acoustically induced vibrations or electromagnetic field excitation induced vibrations are acceptable throughout the declared flight envelope and EHPS operating range for the intended installation configuration.<br/>(c) The effects on vibration characteristics of excitation forces caused by EHPS Fault conditions must be evaluated and shown not to result in a Hazardous EHPS Effect.</p> | EHPS.230(c) is implicit to the FAA reg.                                                                                                                                                                                                                                          |
| Overtorque  | <p>(21) Overtorque<br/>When approval is sought for a transient maximum engine overtorque, the applicant must demonstrate by test, validated analysis, or a combination thereof, that the engine can continue operation after operating at the maximum engine overtorque condition without maintenance action. Upon conclusion of overtorque tests conducted to show compliance with this special condition, or any other tests that are conducted in combination with the overtorque test, each engine part or individual groups of components must meet the requirements of special condition no. 29 of these special conditions.</p>                                                                                                                                                                                                                                                                                                                                                                                                  | <p>EHPS.420 Endurance Demonstration<br/>(b) When approval is sought for a Normal Transient EHPS Exceedance, it must be substantiated that the EHPS is capable of operation at the maximum EHPS transient condition of the affected EHPS parameter(s) without maintenance action.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Difference. EHPS.420(b) allows for transient exceedances for any parameter. FAA SC only allows it for Overtorque only via SC 21. Additionally, EHPS.420 has this demonstration conducted within the endurance test whereas FAA SC allows for this to be conducted independently. |
| Calibration | <p>(22) Calibration Assurance<br/>Each engine must be subjected to calibration tests to establish its power characteristics, and the conditions both before and after the endurance and durability demonstrations specified in special conditions nos. 23 and 26 of these special conditions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>EHPS.440 Calibration Assurance<br/>The EHPS must be subjected to calibration tests that are necessary to establish its power characteristics and the conditions both before and after the endurance and durability demonstrations specified in Subpart D.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Equivalent requirements.                                                                                                                                                                                                                                                         |
| Endurance   | <p>23. Endurance Demonstration<br/>The applicant must subject the engine to an endurance demonstration, acceptable to the Administrator, to demonstrate the engine’s limit capabilities. The endurance demonstration must include increases and decreases of the engine’s power settings, and dwellings at the power settings for durations that produce the extreme physical conditions the engine experiences at rated performance levels, operational limits, and at any other conditions or power settings that are required to verify the limit capabilities of the engine.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>EHPS.420 Endurance Demonstration<br/>(a) The EHPS must be subjected to an endurance demonstration of safe operation under all operational limits to be applied during service operation of the EHPS. The severity of the demonstration must consider the design and intended use of the EHPS and must include sufficient duration with respect to cycles and power settings.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Equivalent requirements. FAA SC is more detailed.                                                                                                                                                                                                                                |

| Description         | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                      | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Assessment                                                                                                                                                                                                                                                                                                                                                                                    |
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| Temperature         | 24. Temperature Limit<br>The engine design must demonstrate its capability to endure operation at its temperature limits plus an acceptable margin. The applicant must quantify and justify to the Administrator the margin at each rated condition. The demonstration must be repeated for all declared duty cycles and associated ratings, and operating environments, that would impact temperature limits.                                       | EHPS 480 EHPS Specific operation<br>(c) For each declared rating with a duration of two minutes or less, it must be substantiated that the EHPS sub-systems (except the propulsion battery if any) can sustain operation at its temperature limits plus a suitable margin.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Significant difference. EHPS.480(c) applies to rating with a duration of 2 minutes or less, while FAA mandates its requirement for all ratings, irrespective of duration.                                                                                                                                                                                                                     |
| Operation           | 25. Operation Demonstration<br>The engine design must demonstrate safe operating characteristics, including but not limited to power cycling, starting, acceleration, and overspeeding throughout its declared flight envelope and operating range. The declared engine operational characteristics must account for installation loads and effects.                                                                                                 | EHPS.460 Operational Demonstration<br>(a) The operational demonstration must include tests, validated analysis, or a combination thereof to demonstrate the proper operability of the EHPS throughout its declared flight envelope and operating range.<br>The declared EHPS operational characteristics must account for installation loads and effects.<br><br>(b) Starting and restarting/relighting<br>(1) The applicant must demonstrate the capability of the EHPS to reliably start under all declared ground atmospheric temperature conditions.<br>(2) The EHPS design must allow the shutdown and restart or the relight of the EHPS, or the affected sub-system of the EHPS, in flight within an established envelope, unless not required for aircraft operation.<br><br>(c) Power Response<br>The design and construction of the EHPS must allow the EHPS to provide a power response that is suitable for the safe operation of intended aircraft application | Equivalent intents. EHPS.460 includes provisions for hybrid applications that are not applicable to the scope of the FAA SC.                                                                                                                                                                                                                                                                  |
| Durability          | 26. Durability Demonstration<br>The engine must be subjected to a durability demonstration to show that each part of the engine has been designed and constructed to minimize any unsafe condition of the system between overhaul periods or between engine replacement intervals if the overhaul is not defined. This test must simulate the conditions in which the engine is expected to operate in-service, including typical start-stop cycles. | EHPS.430 Durability Demonstration<br>The EHPS must be subjected to a durability demonstration to show that each part of the EHPS has been designed and constructed to minimise the probability of failure of the system and sub-systems between overhaul periods, or between replacement intervals of EHPS components/parts. This substantiation must simulate the conditions in which the EHPS is expected to operate in service, including typical start-stop cycles and scheduled maintenance actions and must be of a sufficient duration in order to provide confidence in the durability of the EHPS.                                                                                                                                                                                                                                                                                                                                                                 | In the FAA version, there are two separate provisions: SC5, which is a design requirement, and SC 26 which is a test requirement. EASA SC uses a single provision, EHPS.430 with text equivalent only to the latter (SC26), except that: FAA wording is clear on the word "test"; see last sentence of SC26. The EASA SC uses the word "substantiation" which could mean MoC other than test. |
| System & Components | 27. System and Component Tests<br>The applicant must show that systems and components will perform their intended functions in all declared environmental and operating conditions.                                                                                                                                                                                                                                                                  | EHPS.490 System, equipment and component tests<br>For those systems and components that cannot be adequately substantiated in accordance with endurance tests, validated analysis, or a combination thereof, additional tests must be conducted to demonstrate that systems or components are able to perform their intended functions in all declared environmental and operating conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Different presentation but same intent and outcome.                                                                                                                                                                                                                                                                                                                                           |
| Rotor Locking       | (28) Rotor Locking Demonstration<br>If shaft rotation is prevented by locking the rotor(s), the engine must demonstrate:<br>(a) Reliable rotor locking performance;<br>(b) Reliable rotor unlocking performance; and                                                                                                                                                                                                                                 | EHPS.470 Rotor Locking Demonstration<br>If continued rotation is prevented by a means to lock the rotor(s), the EHPS must be subjected to tests, validated analysis, or a combination thereof that includes repeated locking and unlocking operations to sufficiently establish reliable rotor locking performance.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | No difference.                                                                                                                                                                                                                                                                                                                                                                                |

| Description   | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rotor Locking | (c) That no hazardous engine effects, as specified in special condition no. 17(d)(2) of these special conditions, will occur.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | EHPS.80 Safety Assessment<br>(a) (1) An analysis of the EHPS, including the control system, must be carried out in order to assess all Failure Conditions that can reasonably be expected to occur. This analysis must take account of:<br>(i) The intended aircraft application: the evaluation of the EHPS failures conditions and their effects must be made at aircraft level in coordination with the intended aircraft manufacturer who must establish the probability of occurrence of those failure conditions acceptable for the intended aircraft application. This evaluation of the EHPS failure conditions and associated failure rates must be detailed in the installation instructions as required in EHPS.30 (b)(7). Alternatively, this data must be established and provided in the safety assessment of the intended aircraft application if the EHPS is certified as part of the aircraft certification.<br>(ii) Aircraft-level devices and procedures that are assumed to be associated with the intended aircraft application. Such assumptions must be stated in the analysis, and detailed in the Installation Instructions as required in EHPS.30 (b)(3).<br>(iii) Consequential secondary Failures and dormant Failures.<br>(iv) Multiple Failures that result in the Hazardous EHPS Effects, Hazardous Aircraft Effects or Catastrophic Aircraft Effects defined in EHPS.15. | Slightly different presentation but results in the same intent.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Teardown      | (29) Teardown Inspection<br>(a) Teardown evaluation.<br>(1) After the endurance and durability demonstrations have been completed, the engine must be completely disassembled. Each engine component and lubricant must be eligible for continued operation in accordance with the information submitted for showing compliance with § 33.4.<br>(2) Each engine component, having an adjustment setting and a functioning characteristic that can be established independent of installation on or in the engine, must retain each setting and functioning characteristic within the established and recorded limits at the beginning of the endurance and durability demonstrations. | EHPS.450 Teardown Inspection<br>(a) After the endurance and durability tests have been completed, each EHPS must be subject to a strip inspection. The condition of the EHPS must be satisfactory for safe continued operation. EHPS components and equipment that function separately must be functionally checked prior to strip to ensure that any changes in function or settings are satisfactory for normal operation.<br>(b) Each EHPS component that has any adjustable setting or has a functional characteristic that can be established independent of installation on or in the EHPS, must retain each setting and functional characteristic within the limits that were established and recorded at the beginning of the demonstration.<br>(c) If the results of the teardown inspection show that the replacement of a part is necessary then the EHPS or its parts must be subjected to any additional tests that the Agency finds necessary.                                                                                                                                                                                                                                                                                                                                                                                                                                             | EHPS.450(a) and SC 29(a)(1) are different. EHPS.450 only establishes that the engine must be satisfactory for safe operation, which is only one part of airworthiness. SC 29(a)(1) requires that the engine is within serviceable limits and eligible for continued operation, which touches on both portions of airworthiness (assuming continued operation means safe operation, which it should).<br><br>EHPS.450(b) and SC 29(a)(2) are the same.<br><br>EHPS.450(c) is not equivalent to SC 29(a). This is a difference. Maybe EHPS.450(c) is equivalent to SC 32(b)(4)? |
| Teardown      | (b) Non-Teardown evaluation. If a teardown cannot be performed for all engine components in a non-destructive manner, then the inspection or replacement intervals for these components and lubricants must be established based on the endurance and durability demonstrations and must be documented in the ICA in accordance with § 33.4.                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Difference. Not included in SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| Description      | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | SC E-19                                                                                                                                                                                                                                                                                                                                                                                           | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Containment      | <p>(30) Containment</p> <p>The engine must be designed and constructed to protect against likely hazards from rotating components as follows—</p> <p>(a) The design of the stator case surrounding rotating components must provide for the containment of the rotating components in the event of failure, unless the applicant shows that the margin to rotor burst precludes the possibility of a rotor burst.</p> <p>(b) If the margin to burst shows that the stator case must have containment features in the event of failure, then the stator case must provide for the containment of the failed rotating components. The applicant must define by test, validated analysis, or a combination thereof, and document and provide to the installer as part of the requirements in § 33.5, the energy level, trajectory, and size of fragments released from damage caused by the main-rotor failure, and that pass forward or aft of the surrounding stator case.</p> | <p>EHPS.250 Rotating parts containment</p> <p>(a) The failure of any rotating component or part of an equipment, electric engine or generator must not lead to the release of high energy debris.</p>                                                                                                                                                                                             | <p>Significant differences.</p> <p>-FAA SC allows for the margin to burst approach, which the EASA SC does not mention.</p> <p>-The EASA SC refers to 'high energy debris', while the FAA requires case contains any debris (radially) and fragments passing forward and aft of the case to be documented in the IM.</p> <p>This definition of 'high energy' may lead to a difference; what is the energy threshold? Also, an internal rotorburst is likely to result in damage and release of non-rotating components as a consequence of the failure of the main rotor.</p> |
| Variable Pitch   | <p>31. Operation With a Variable Pitch Propeller (from magniX Special Condition as this is not in Beta's SC)</p> <p>The applicant must conduct functional demonstrations including feathering, negative torque, negative thrust, and reverse thrust operations, as applicable, with a representative propeller. These demonstrations may be conducted in a manner acceptable to the Administrator as part of the endurance, durability, and operation demonstrations.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p>EHPS 480 EHPS Specific operation</p> <p>(a) If the EHPS is designed to operate with a propeller or an aircraft rotor, all applicable EHPS demonstrations required by this special condition must be performed with a representative propeller or aircraft rotor.</p>                                                                                                                           | <p>Difference. FAA SC 31 only applies to fixed wing application. EHPS.480 includes helicopter applicability as well.</p> <p>EHPS.480 requires that this function must be present during all demonstrations (including endurance, durability and operations) whereas SC 31 states that it can be done during one of the demonstrations but it is not a requirement that it be demonstrated for all regulations</p>                                                                                                                                                             |
| Conduct of tests | <p>(32) General Conduct of Tests</p> <p>(a) Maintenance of the engine may be made during the tests in accordance with the service and maintenance instructions submitted in compliance with § 33.4.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>EHPS.410 General Conduct of Tests</p> <p>(a) Maintenance of the EHPS is permitted during the tests in accordance with the service and maintenance instructions submitted in the Instructions for Continued Airworthiness defined in paragraph EHPS.25.</p>                                                                                                                                     | <p>No difference</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Conduct of tests | <p>(b) The applicant must subject the engine or its parts to any additional tests that the Administrator finds necessary if—</p> <p>(1) The frequency of engine service is excessive;</p> <p>(2) The number of stops due to engine malfunction is excessive;</p> <p>(3) Major engine repairs are needed; or</p> <p>(4) Replacement of an engine part is found necessary during the tests, or due to the teardown inspection findings.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p>(b) The EHPS or its parts must be subjected to any additional tests and maintenance that the Agency finds necessary, if during the tests:</p> <p>(1) the frequency of maintenance during the testing is excessive;</p> <p>(2) the number of stops due to EHPS malfunction is excessive;</p> <p>(3) a major repair is required; or</p> <p>(4) the replacement of a part is found necessary.</p> | <p>No difference</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Conduct of tests | <p>(c) Upon completion of all demonstrations and testing specified in these special conditions, the engine and its components must be—</p> <p>(1) Within serviceable limits;</p> <p>(2) Safe for continued operation; and</p> <p>(3) Capable of operating at declared ratings while remaining within limits.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                   | <p>Difference. SC 31(c)(2)(3) may be implicit or referenced by other special conditions, but SC 31(c)(1) is omitted from SC E-19.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Description              | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | SC E-19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Engine Electrical System | <p>(33) Engine Electrical Systems</p> <p>(a) Applicability.</p> <p>Any system or device that provides, uses, conditions, or distributes electrical power, and is part of the engine type design, must provide for the continued airworthiness of the engine, and must maintain electric engine ratings.</p> <p>(b) Electrical systems.</p> <p>The electrical system must ensure the safe generation and transmission of power, and electrical load shedding if required, and that the engine does not experience any unacceptable operating characteristics or exceed its operating limits.</p> <p>(c) Electrical power distribution.</p> <p>(1) The engine electrical power distribution system must be designed to provide the safe transfer of electrical energy throughout the powerplant. The system must be designed to provide electrical power so that the loss, malfunction, or interruption of the electrical power source will not result in a hazardous engine effect, as defined in special condition no. 17(d)(2) of these special conditions.</p> <p>(2) The system must be designed and maintained to withstand normal and abnormal conditions during all ground and flight operations.</p> <p>(3) The system must provide mechanical or automatic means of isolating a faulted electrical energy generation or storage device from leading to hazardous engine effects, as defined in special condition no. 17(d)(2) of these special conditions, or detrimental effects in the intended aircraft application.</p> | <p>EHPS.370 Electrical power generation, distribution and wirings</p> <p>(a) The electrical power generation, distribution and wirings of the EHPS must be designed and constructed so as to meet the Type-Certification basis of the intended aircraft application.</p> <p>(b) The electrical power generation, distribution and wirings of the EHPS for any sub-system, as applicable, must be designed and installed to supply the power required for operation of connected loads during all intended operating conditions.</p> <p>(c) Operation of connected loads must have no detrimental effects on the Electrical power generation, distribution and wirings.</p> <p>(d) Disconnection of loads must have no detrimental effects on the Electrical power generation, distribution and wirings.</p> | <p>Several significant differences in the text.</p> <ul style="list-style-type: none"><li>- SC E-19 explicitly ties to specific airframes whereas the FAA SCs allow for certification within an envelope.</li><li>- FAA SC has more explicit design requirements, such as load shedding.</li><li>- Potential deviation in that SC E-19 states no detrimental effects whereas FAA states no unacceptable operating characteristics or exceeding operating limits.</li><li>- FAA SC may allow some detrimental effects during disconnection of loads as long as they do not result in hazardous engine effects. SC E-19 does not allow detrimental effects.</li><li>- FAA SC requires isolation.</li></ul> |

| Description              | FAA Electric SC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | SC E-19 | Assessment                                       |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--------------------------------------------------|
| Engine Electrical System | <p>(d) Protection systems.<br/>The engine electrical system must be designed such that the loss, malfunction, interruption of the electrical power source, or power conditions that exceed design limits, will not result in a hazardous engine effect, as defined in special condition no. 17(d)(2) of these special conditions.</p> <p>(e) Electrical power characteristics.<br/>The applicant must identify, declare, document, and provide to the installer as part of the requirements in § 33.5, the characteristics of any electrical power supplied from—</p> <p>(1) the aircraft to the engine electrical system, for starting and operating the engine, including transient and steady-state voltage limits, and</p> <p>(2) the engine to the aircraft via energy regeneration, and any other characteristics necessary for safe operation of the engine.</p> <p>(f) Environmental limits.<br/>Environmental limits that cannot adequately be substantiated by endurance demonstration, validated analysis, or a combination thereof must be demonstrated by the system and component tests in special condition no. 27 of these special conditions.</p> <p>(g) Electrical system failures.<br/>The engine electrical system must—</p> <p>(1) Have a maximum rate of loss of power control (LOPC) that is suitable for the intended aircraft application;</p> <p>(2) When in the full-up configuration, be single-fault tolerant, as determined by the Administrator, for electrical, electrically detectable, and electronic failures involving LOPC events;</p> <p>(3) Not have any single failure that results in hazardous engine effects; and</p> <p>(4) Ensure failures or malfunctions that lead to local events in the intended aircraft application do not result in hazardous engine effects, as defined in special condition no. 17(d)(2) of these special conditions, due to electrical system failures or malfunctions.</p> <p>(h) System safety assessment.<br/>The applicant must perform a system safety assessment. This assessment must identify faults or failures that affect normal operation, together with the predicted frequency of occurrence of these faults or failures. The intended aircraft application must be taken into account to assure the assessment of the engine system safety is valid. The rates of hazardous and major faults must be declared, documented, and provided to the installer as part of the requirements in § 33.5.</p> |         | Difference. No equivalent requirement in SC E-19 |





## APPENDIX B ACRONYMS

An alphabetical list of all acronyms used in this document.

*Table 2 - List of Acronyms*

| Acronym | Definition                                                                                                                                                                                                                                                                                                                                   |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CFR     | Code of Federal Regulations                                                                                                                                                                                                                                                                                                                  |
| EASA    | European Union Aviation Safety Agency                                                                                                                                                                                                                                                                                                        |
| CFR     | Code of Federal Regulations                                                                                                                                                                                                                                                                                                                  |
| CS      | Certification Specifications                                                                                                                                                                                                                                                                                                                 |
| EHPS    | Electric Hybrid Propulsion Systems                                                                                                                                                                                                                                                                                                           |
| FAA     | Federal Aviation Administration                                                                                                                                                                                                                                                                                                              |
| FAR     | Federal Aviation Regulations (deprecated with the introduction of “Federal Acquisition Regulations”). Used in this report as a short-hand reference to Title 14 of the Code of Federal Regulations for Aeronautics and Space, especially Chapter I, Federal Aviation Administration, Subchapter C, Aircraft, which refers to Parts 21 to 59. |
| ICA     | Instructions for Continued Airworthiness                                                                                                                                                                                                                                                                                                     |
| LCF     | Low-Cycle Fatigue                                                                                                                                                                                                                                                                                                                            |
| LOPC    | Loss of Power Control                                                                                                                                                                                                                                                                                                                        |
| LSA     | Light Sport Aeroplane ( <i>EASA spelling</i> )                                                                                                                                                                                                                                                                                               |
| LSA     | Light-Sport Aircraft ( <i>FAA spelling</i> )                                                                                                                                                                                                                                                                                                 |
| MOC     | Means of Compliance                                                                                                                                                                                                                                                                                                                          |
| NASA    | National Aeronautics and Space Administration                                                                                                                                                                                                                                                                                                |
| SC      | Special Condition                                                                                                                                                                                                                                                                                                                            |
| TC      | Type Certificate                                                                                                                                                                                                                                                                                                                             |
| UAS     | Unmanned Aircraft System                                                                                                                                                                                                                                                                                                                     |
| VFR     | Visual Flight Rules                                                                                                                                                                                                                                                                                                                          |
| VTOL    | Vertical Take-Off and Landing                                                                                                                                                                                                                                                                                                                |