

Electric and Hybrid Propulsion System (EHPS)

EASA roadmap

EASA webinar – 22-06-2021

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EHPS – enablers to aviation change

Innovation

Creativity

New propulsion
architectures

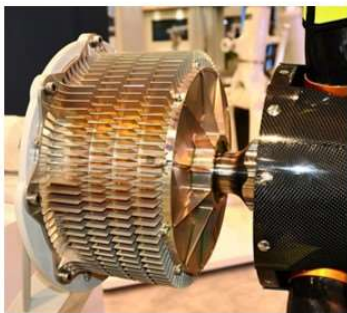
Challenges

Sustainability

New opportunities



EHPS – what are we talking about?



Safran (www.cleantechnica.com)



Volocopter

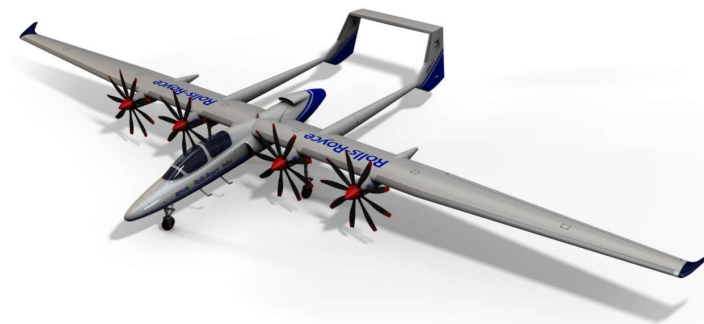


MAHEPA

From single electric engine to complete hybrid and distributed propulsion systems



Lilium



Apus and Rolls-Royce

A step by step approach with clear objectives

→ Process:

- Learning by doing
- Starting with small products and gaining experience
- Building progressively adequate set of requirements

→ Key Objectives:

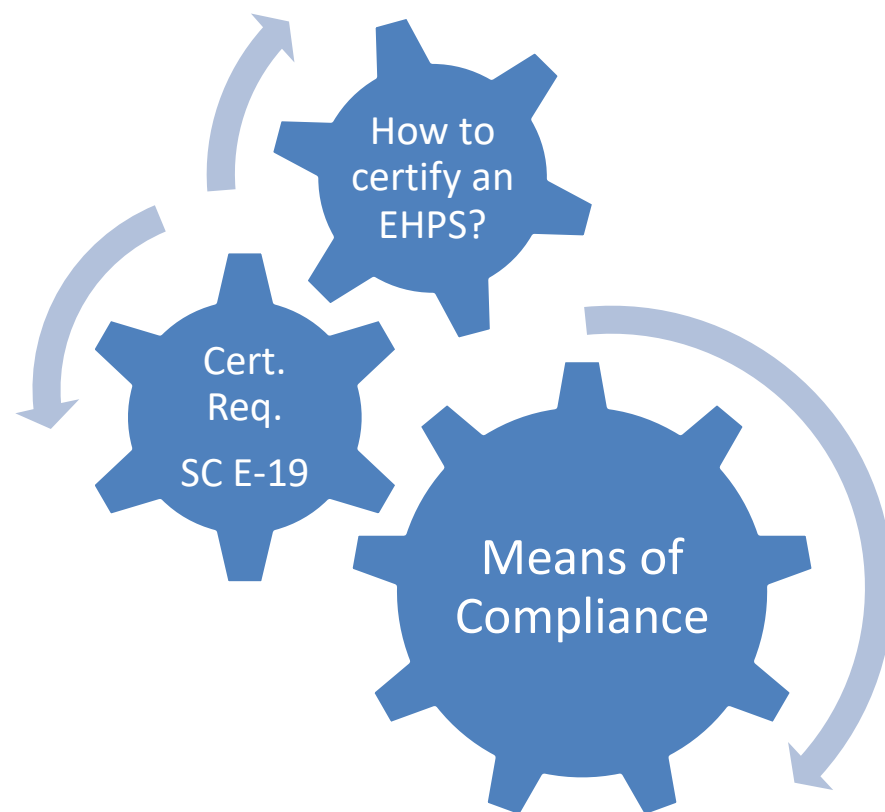
- Promoting safety
- Promoting sustainability
- Promoting innovation: strong interactions with industry upfront the certification projects
- Ensuring a fair level playing field
- Promoting proportionality
- Promoting harmonization with foreign authorities
- Promoting active involvement of the industry

Safety continuum

Proportionality

- SC E-01: Airworthiness standard for CS-22H Electrical retractable engine to be operated in powered sailplanes
- SC-22.2014-01 issue 2: Installation of electric propulsion units in powered sailplanes
- CS-LSA → ASTM F2840-11: Standard Practice for Design and Manufacture of Electric Propulsion Units for Light Sport Aircraft
- SC LSA-15-01 – Light Sport Aircraft – Electric Propulsion Powerplant
- SC E-18 issue 2 - Electric Propulsion Units for CS-23 Normal-Category Aeroplanes up to Level 1 (aim to make use of ASTM F3338-18 to have a joined approach with the FAA)
- SC E-19 – Electric / Hybrid Propulsion System (EHPS)

EHPS certification



Next steps

- Development of MoC to SC E-19
- How to certify EHPS?
- Set of requirements to support generic EHPS certification: 2 steps approach
- Hydrogen (to feed fuel cells or as direct combustion into engines)

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Introduction to SC E-19

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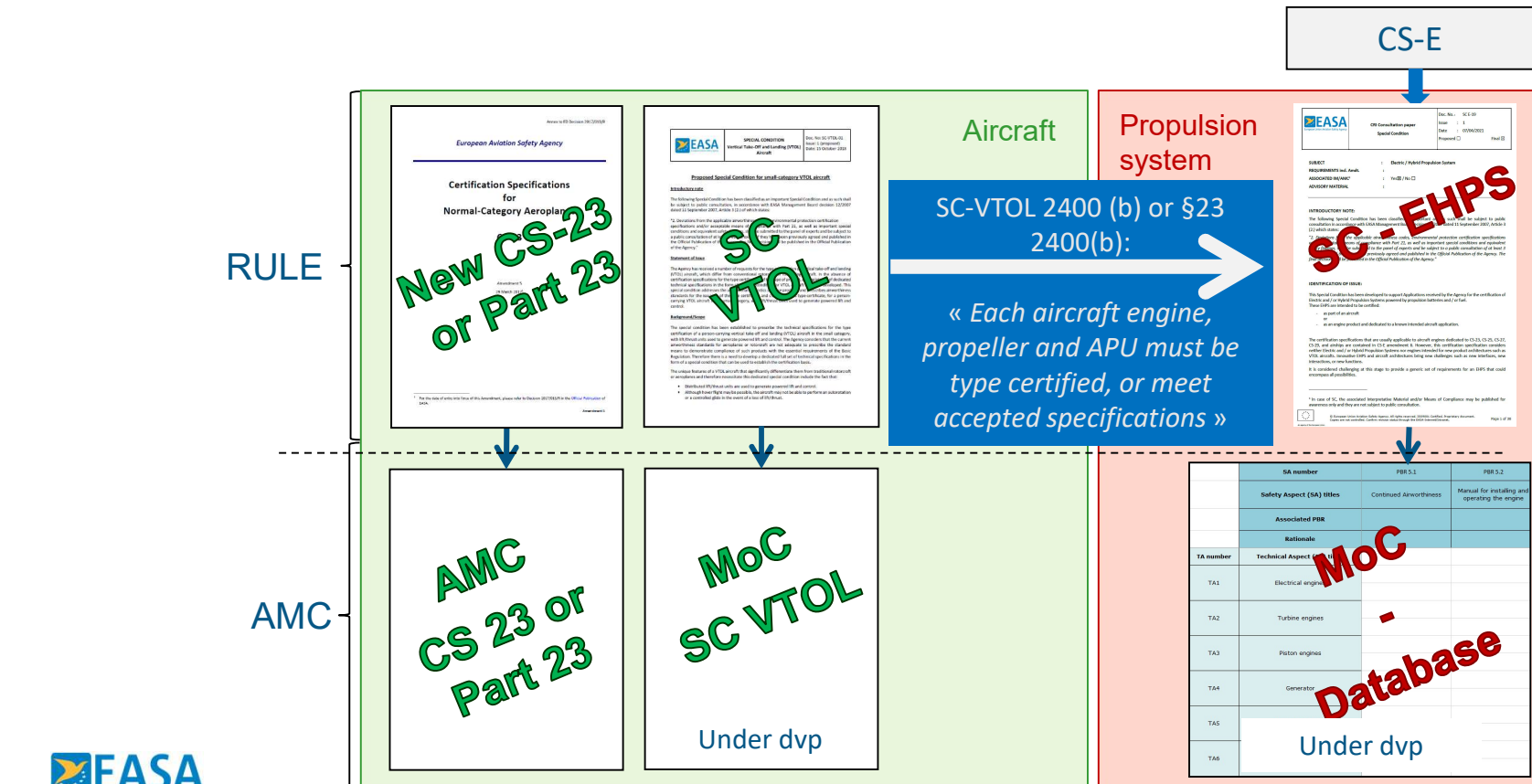
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- History of the SC EHPS
- Interactions with A/C requirements
- Scope
- Safety assessment – EHPS.80 / Link with A/C activities
- Means Of Compliance

History of the SC EHPS

- Work initiated in 2019 and idea shared in various forums (SAE E-40, CAPP meetings...)
- Proposed SC E-19 published for public consultation on 27/01/2020
- 559 comments answered: [CRD](#)
- [Final version of SC E-19](#) published on 07/04/2021

How does SC E-19 interacts with A/C req?



EHPS definition

→ EHPS.15 Terminology:

An Electric / Hybrid Propulsion System may include, but is not limited to, electric engines, turbine engines, piston engines, generators, electrical power generation, distribution, wirings, propulsion batteries, integrated fans, cooling systems, controllers and power management system.

An EHPS is intended to produce lift, thrust or power for flight and it should include as a minimum the sub-systems of the EHPS that provide thrust, lift or power to a device that provides thrust or lift, such as a propeller or an aircraft rotor.

Scope

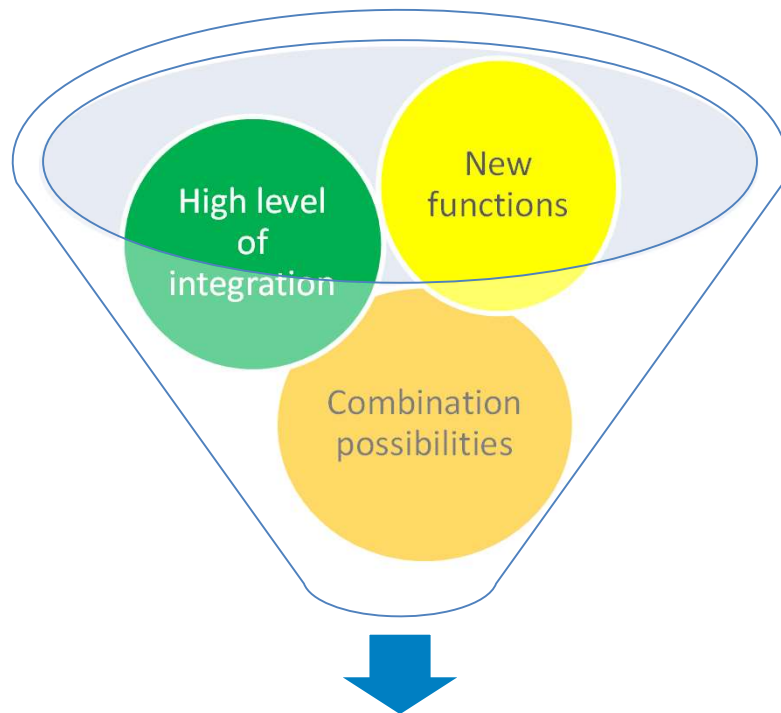
→ IN

- EHPS dedicated to CS-23, CS-25, CS-27, CS-29, VTOL
- The intended A/C application(s) must be known
- Fans

→ OUT:

- EHPS dedicated to CS-22, CS-LSA, CS-23 Level 1 day VFR (former VLA), Light UAS
- EHPS not used to produce lift/thrust/ power for flight sustentation
- Generic EHPS without known A/C application
- Hydrogen usage
- Propeller or A/C rotors

Scope – why must the A/C application be known?



Difficulty to issue generic safety objectives that fit all solutions

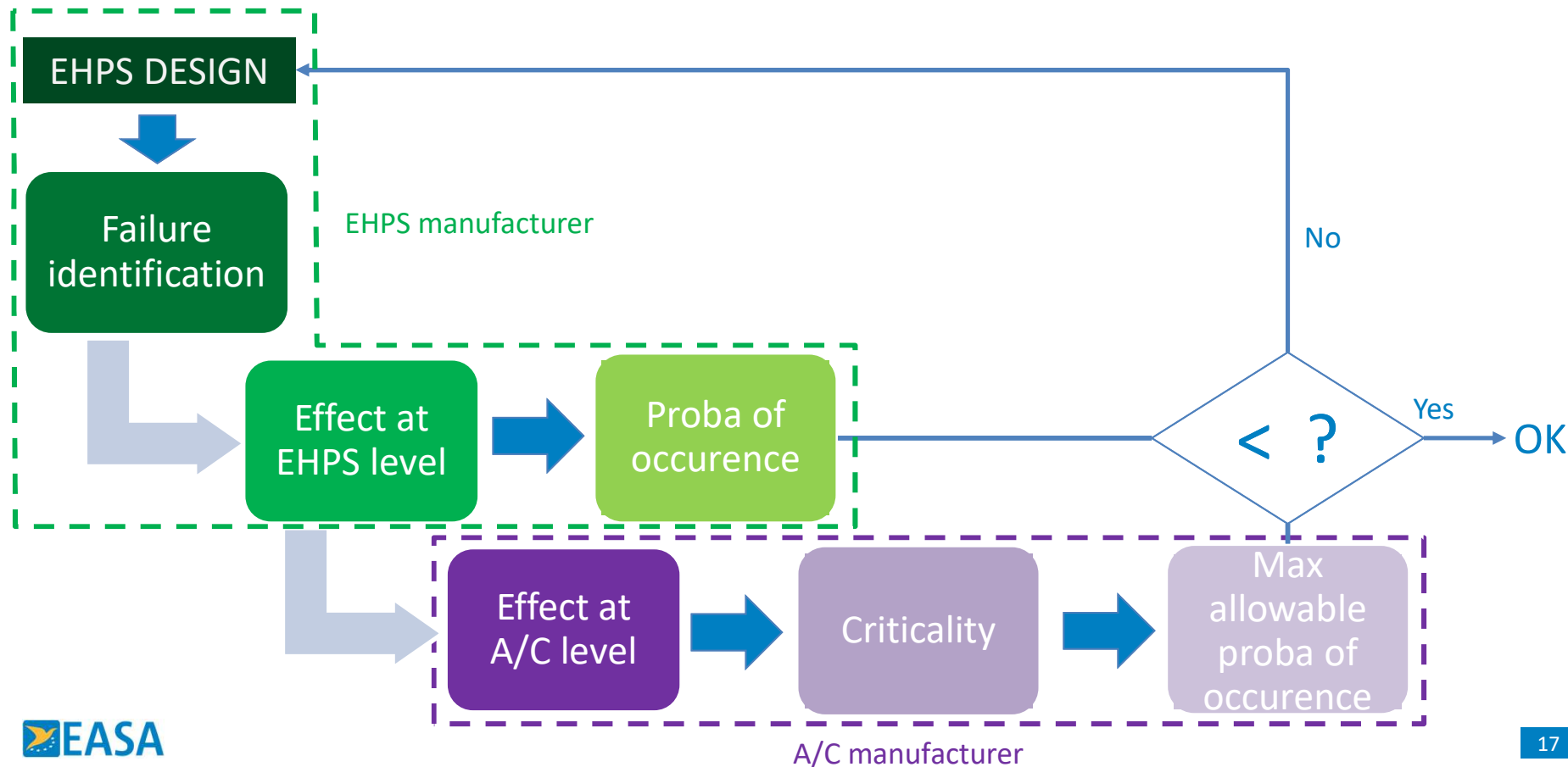


Safety objectives must be derived from the A/C ones

EHPS.80 (a) (1) (i)

- (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:
- (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.

EHPS.80 (a) (1) (i) – iterative process



EHPS.80 (a) (3)

- (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.

Means of Compliance – W.I.P.

→ « A la carte » concept

Specific technical aspects

Requirements

	...	EHPS.230 Vibration Survey	EHPS.240 Overspeed and rotor integrity	...	EHPS.290 Bird, hail strike and impact of foreign matter	...
Adjacent engines		N/A	N/A		X	
Fan		X	X		X	
Electric engine		X	X		X	
Turbine		X	X		X	
High voltage						
...						

Inputs:
CS-E, AMC CS-E, CM, CRI,
appropriate
Standards (ASTM,
SAE, EUROCAE...)

Electric and Hybrid Propulsion System (EHPS)

How to certify EHPS

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Definitions in EASA framework

- Basic Regulation 2018/1139 defines 3 products that can get a TC: aircraft, engine, propeller.
- According to Basic Regulation 2018/1139, engine and propeller can now be certified as part of the aircraft certification.
- No binding definition of “engine” in Basic Regulation 2018/1139.
- Point 1.2.1 of Annex II to the Basic Regulation (Essential requirements for airworthiness) defines “propulsion system” as “engine and, where appropriate, propeller” → a “propulsion system” cannot get a TC as such but it can be the sum of 2 TC (an engine TC and where appropriate a propeller TC)
- CS Definitions provides a definition of engine: *“Engine” means an engine used or intended to be used for aircraft propulsion. It consists of at least those components and equipment necessary for the functioning and control, but excludes the propeller.*

EHPS

- ❖ The Electric and Hybrid Propulsion System (EHPS) are stretching the boundaries of what a *traditional* engine type certificate is being considered.
- ❖ The modular versatility is very high, and the *engine* architectures could be extremely diverse.
- ❖ EHPS systems could be of such a high level of integration within the aircraft that it might be even not possible to set practical *product* boundaries.
- ❖ Within this context, EASA approach is to offer as maximum flexibility to address these innovative concepts while remaining, at the same time, within the current EU legal framework

EHPS

→ Three ways to certify an EHPS have been identified in accordance with the EASA legal framework:

- as part of the aircraft (so-called '**Aircraft approach**'), possible per new Basic Regulation
- as an engine product and where appropriate a propeller product (so-called '**Engine approach**') by determining ***those components and equipment*** (of the EHPS) ***necessary for the functioning and control*** (in line with engine definition)
- as separate elements (so-called '**ETSO approach**') by determining which components of an EHPS could be considered as ETSO articles (if mature standards can support the ETSO approval) – to be further worked before being adopted by EASA

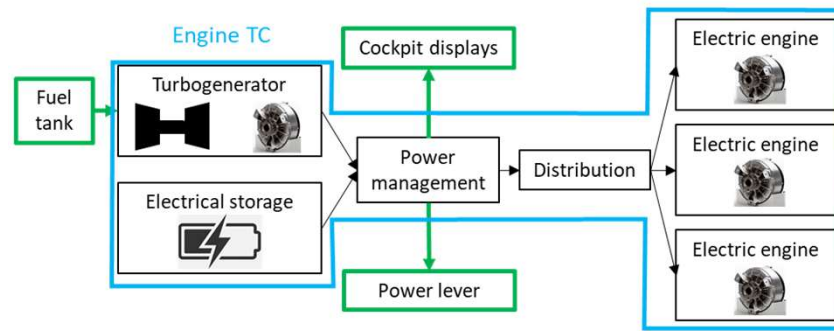
KEY POINT: ensure consistency on certification requirements whatever the chosen certification approach



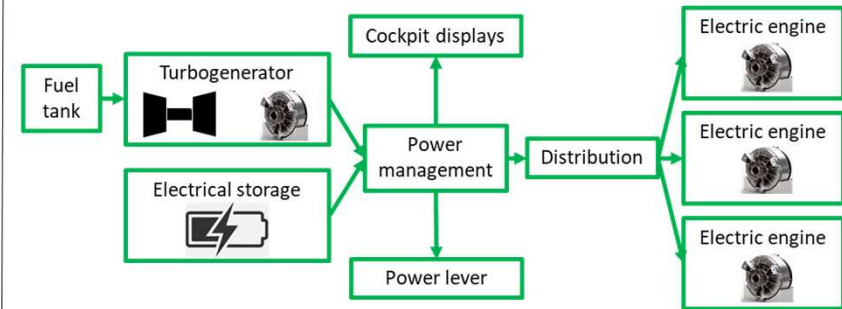
Aim of the SC E-19

Example of possibilities

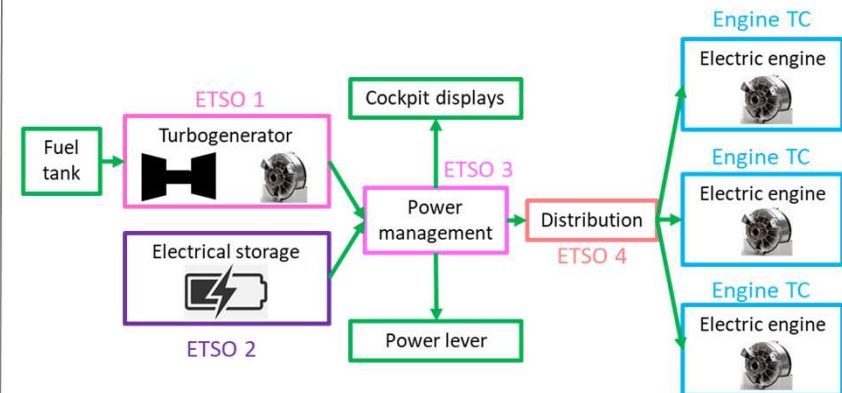
Aircraft approach
Parts and components certified under the aircraft TC



Engine approach



ETSO approach

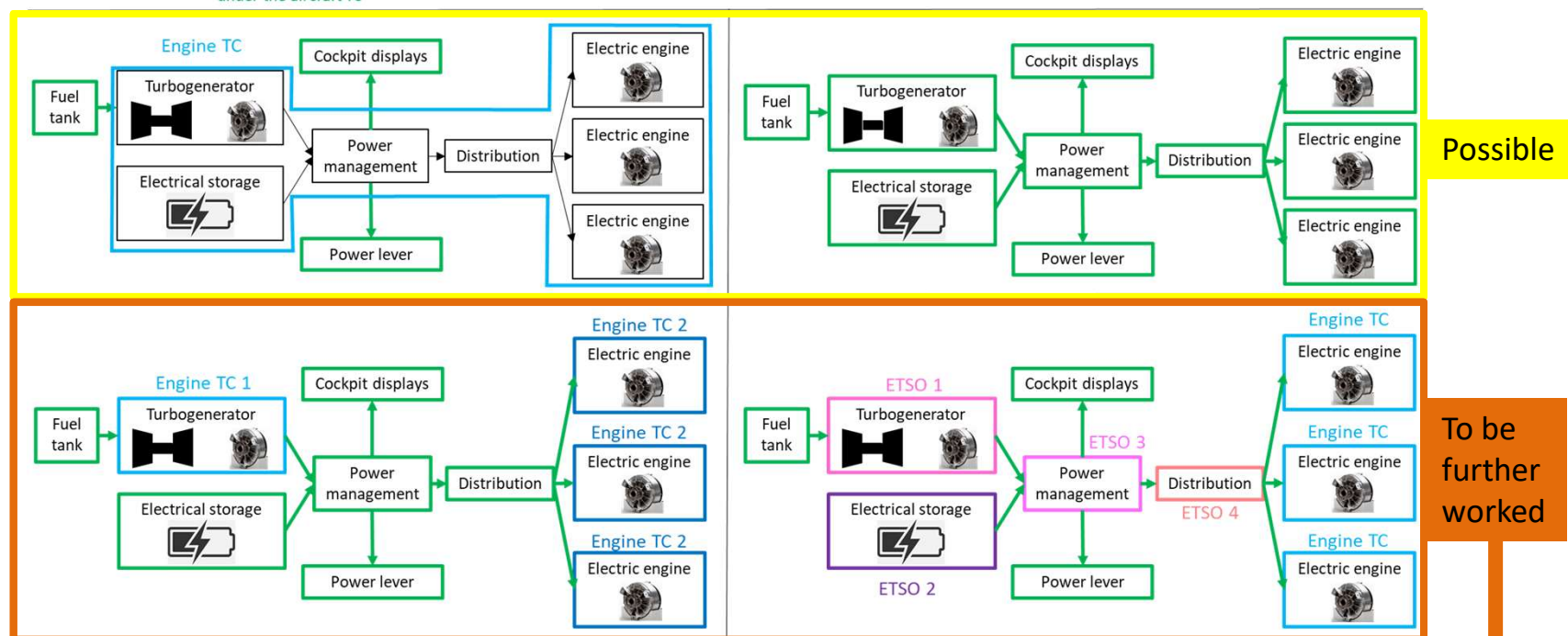


How to certify an EHPS in EASA?

Aircraft approach
Parts and components certified
under the aircraft TC

Engine approach

ETSO approach



Risks foreseen by EASA:

- No mature standards yet to support ETSO
- Dilution of the responsibilities in CAW
- How to manage this approach if not harmonized worldwide?

Next steps

- Review and analyse the answers to the questionnaire
- Proposals of way forward
- Trigger discussions at ICAO level
- Initiate reflections for Hydrogen based propulsion system

Electric and Hybrid Propulsion System (EHPS)

Next evolution: 2 steps approach to certify a generic EHPS

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Acknowledgment

- The current scope of the SC E-19 supports on-going certification projects
- But SC E-19 currently excludes stand-alone certification of “generic EHPS” products without known aircraft application
- There is a wish from the industry to certify “generic EHPS”
- So the scope of SC E-19 may limit business development such as retrofits solution to change from combustion engine to greener propulsion system
- Challenge: how to define a set of requirements to cover generic EHPS?

Proposal of SC E-19 update

→ SC E-19 update with a 2 steps approach

- Several subparts dedicated to the certification of a generic EHPS in order to provide a certain level of safety
- One dedicated subpart to cover a specific intended A/C application and ensure consistency between A/C requirements and EHPS requirements

→ PROs:

- Certification of generic EHPS
- Pave the way to certify the EHPS for a specific intended A/C application
- Consistency between A/C and EHPS requirements is ensured
- Certification process already used for the certification of propellers

Analogy with certification of propellers

- CS-P - SUBPART D – Propeller vibration, fatigue evaluation and flight functional tests
- CS-P 510 Applicability states:
 - *“This subpart prescribes the tests and evaluations to be performed on the Propeller with the engine and airframe combination for which approval is sought”*

This means that a propeller manufacturer can get a generic TC without covering the Subpart D. When he seeks the certification for a specific installation, he (or the A/C manufacturer) has to show compliance to Subpart D

Thanks for your attention!

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After the WEBINAR...

- Slides will be made available at the end of the day on the EASA website.
- Each participant will receive via Email a link to a questionnaire asking for a feedback on the topics presented during this Webinar
- EASA will analyse the answers to the questionnaire to adjust its roadmap on EHPS