CASSIO330 Project: Innovation and Certification Challenges

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EASA
European Union Aviation Safety Agency

Certification Conference

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Cologne

VoltAero Company

The founders

VoltAero was established in September 2017 and is based in the Nouvelle Aquitaine region of France.

A diversified Team with global experience and complementary skills: TECHNOLOGY & VISION, BUSINESS & LEGAL ASPECTS, CRAFTSMANSHIP

JEAN BOTTI

CEO | CTO

Ex-Chief Technical Officer in Airbus

MARINA EVANS

General Director

Ex-Airbus Group Innovation

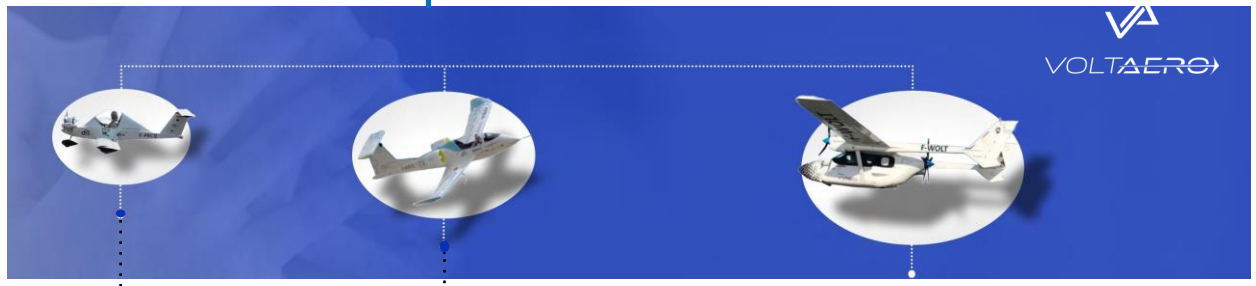
DIDIER ESTEYNE

Technical Director | Test Pilot

CRI-CRI & EFAN Electric Aircraft Designer

Our history: been there, done that!

The recent past…



2011 - ELECTRIC CRI-CRI

Propulsive power 20Kw

2015 - E-FAN

Propulsive power 60Kw

1st electric airplane to cross the Channel!

2020 - CASSIO 1

Propulsive power 600kW

First official flight in october 2020
More than 130 Fhrs

The first in the world and the most advanced and Powerful Parallel Hybrid Aircraft in its class

…today and tomorrow…

2023 – CASSIO S

First official flight 7th Sept.'23 fueled by SAF (bioethanol) Excellium Racing 100 from TotalEnergies. In full hybrid mode, CO_2 reduction of approximately 80%

2023 - FAL Rochefort

New greenfield VoltAero plant start construction. Groundbreaking Ceremony: 3rd Oct 2023

*Benefitting from **80-plus years of combined pioneering expertise**, VoltAero is developing a truly unique general aviation airplane with **hybrid-electric propulsion** for **safe, quiet, efficient and eco-friendly flight***

CASSIO Family:
330, 480, 600

CASSIO Project: Overall Roadmap

CASSIO1
600kW
1h50' of flight time
110 knots
370kms range

2020-2021

CASSIO S
First official flight 7th September 2023 with SAF - CO_2 reduction of approximately 80 percent

2023

June 2023:
@Paris Air Show

Aug 2023:
@EAA AirVenture

Cassio 330
4/5 seats
Hybrid 330 kW
Fixed LG

2025-Q1'26

Cassio 480
6 seats
Hybrid 480kW
Retractable LG

2026-'27

Cassio 600
12 seats
Hybrid Turboprop
Retractable LG

Cassio 330: Certification Highlights

CASSIO 330 will be certified in Normal Category Lev. 2 (5 seats): REF. CRI-A01

AIRCRAFT

Electrical/Hybrid PU

- **CS-23 Amdt 5**
- **CS-ACNS Iss.2**
- **CS-36**
  ICAO Annex16 Vol1-Part II
- **SC-XX for Gear Box (tbd)**
- **SC-E 19**

- CAI 07-001 Cassio330 - electric engine configuration and certification approach
- CAI 01-001 Cassio330 - Use of the ac as single engine / hybrid configuration

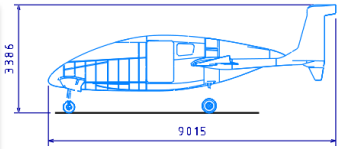
AMC - Proposed through CCL:

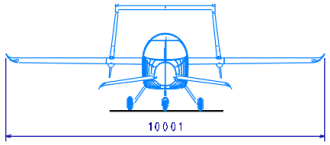
- **AMC1 (ASTMs)** (for all the novel aspects)
- **AMC2 (CS-23Amdt4)** (only for some conventional topics)
- **CS E/CS 22-H** (for RE)
- **DO160G/ED14G** for Equipments Env. Qualification
- **DO-178C/ED-12C** for S/W

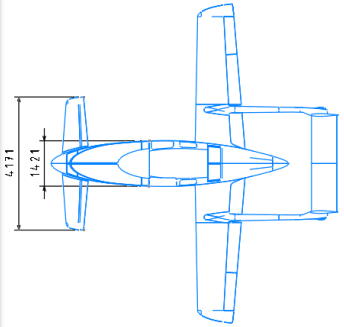
Other Guidelines (for propulsion battery):

- EASA MOC SC-VTOL & CS23 (not published yet)
- DO 311A
- AC20-184
- …
- …

…in progress…





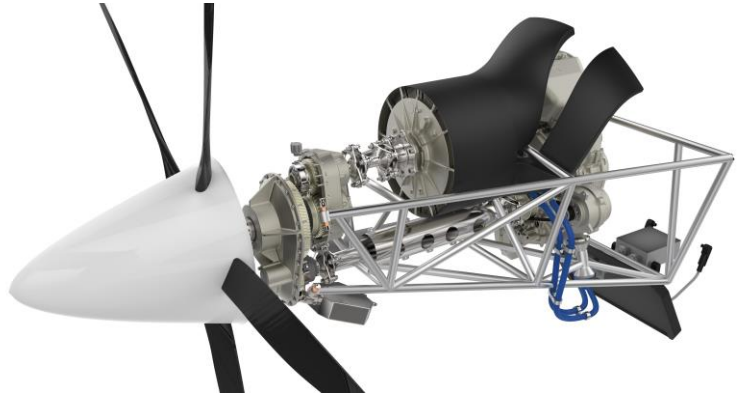


- *Max Seats 5*
- *Hybrid-Single Pusher Prop.*
- *MTOW=1930Kg*
- *Fixed LG*

- The Cassio 330 is considered ELA2 aircraft → compliance to CS MMEL or CS GEN MMEL is not required
- Due to the novelties in the proposed design, EASA may identify further SCs

CASSIO 330

Challenges and Discussion Points



Higher criticalities are mainly related to:

- HPU architecture
- HV propulsion Batteries
- Operational aspects
- Level of novelties + new rule still in development
- ….

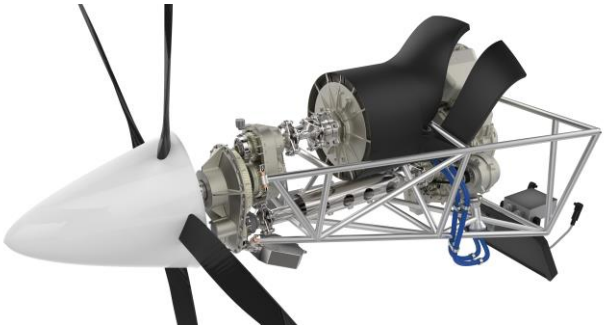
Other topics related to specific unconventional design aspects → **lower criticalities**:

CS 23 Amdt 5 allows more **flexibility** thanks to the possibility to adopt consensus standards as AMC → **proposed MoC** → MoC **CRI** or **SC**

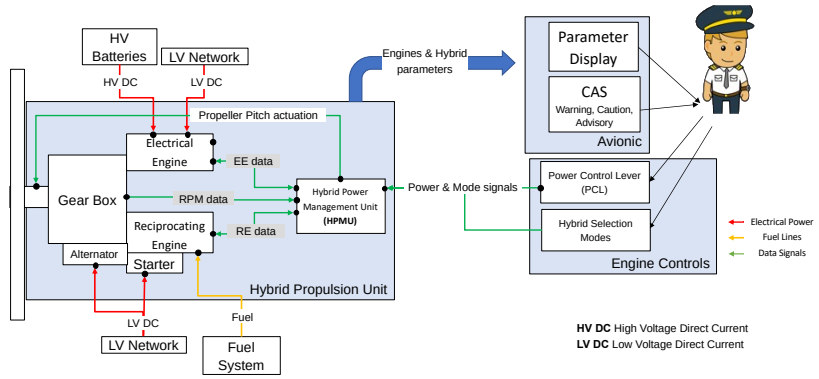
Discussion Points

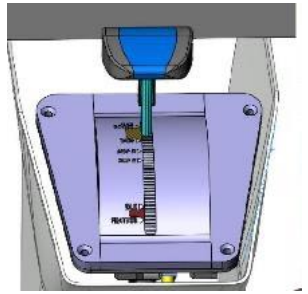
CASSIO 330

HPU Challenges



- Thermal Engine: from motorbike, to be certified as part of the A/C
- Electrical Engine: by SEP → covered by TC
- Gear Box: requirements to discuss and agree
- HPMU: Development SW (and HW), Single lever + hybrid mode selector
- Avionics integration (display parameters, CAS, …)
- Operational Rules: day/night VFR & IFR single pilot



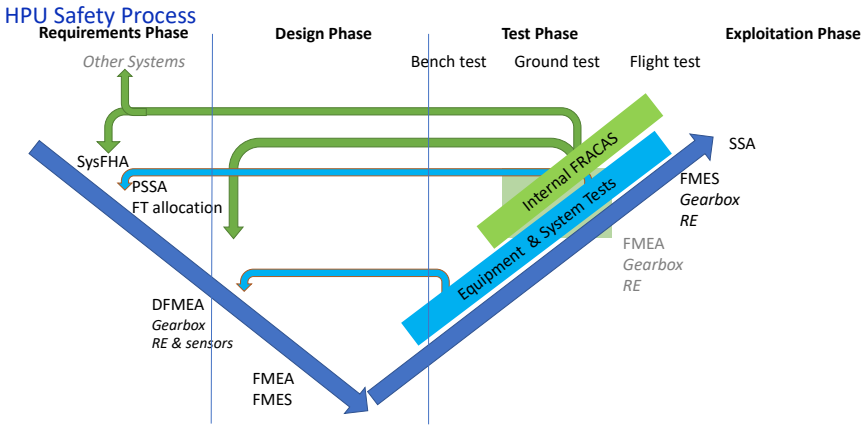


CAI-01-001: Use of the a/c as single engine

CASSIO 330

HPU Challenges: Approach

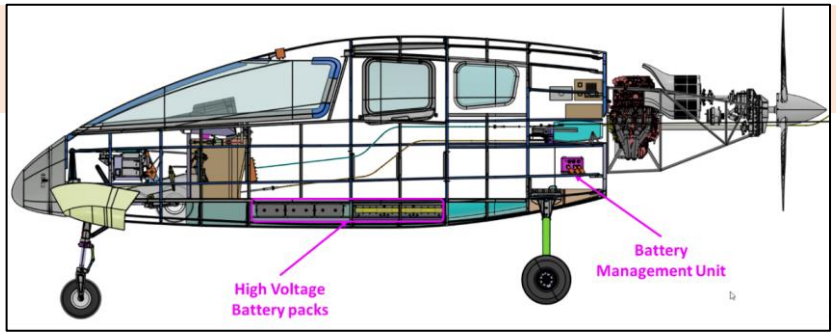
- Safety Analysis @ A/C and System Level Based on SAE-ARP (4754, 4761) and ASTM (F3309M, F3230) standards guidelines
- Test matrix (MoC 4, 5, 9): a build up approach →
  - ➢ *bench test (MoC4) on single components, and on integrated system,*
  - ➢ *ground test (MoC5) for integration on board…*
- HPMU development and qualification (DO-160G, DO-178C)
- De-risk Approach: initial development flight with CASSIO21X (**only Thermal Engine**)
- Integration in **full HPU** installation (CASSIO330 proto)…
- ….and then go to fly (MoC 6)



CASSIO 330

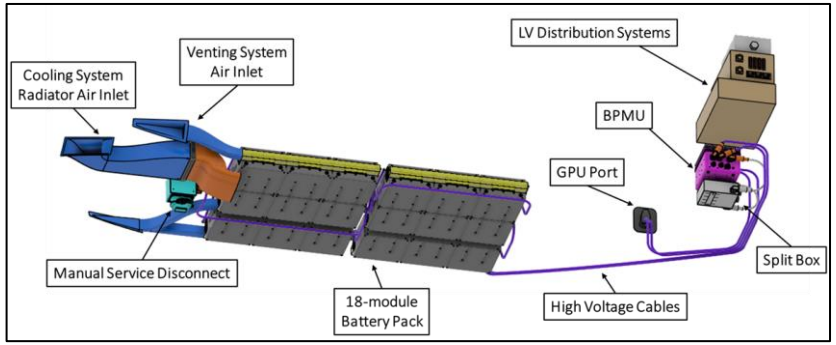
HV Batteries Challenges

- Thermal Runaway management (cell-to-cell propagation)
- Automatic disconnection during discharge…
- Structural protection (crashworthiness)
- ….



Definition of safety objectives (prevention & containment) @ various levels: cell, battery, A/C integration:

- ➢ High Level Req. (CS-23 Amdt5/6)
- ➢ MoC in development (MOC3 SC-VTOL could be a guideline also for CS-23; DO-311A; …)



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Discussion Points

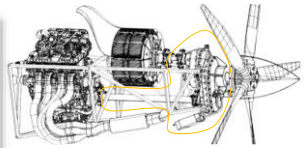
CS 23.2225 **Component loading conditions**

Limit Engine Torque (Design)

ASTM F3116 (6.1.3) | CS 23.361 (c)

Installation type	Coefficient
Turbo-propeller installations	1.25
Engines with 5 or more cylinders	1.33
Engines with 4, 3 or 2 cylinders resp.	Resp. 2, 3 and 4

Design Loads definition for Gear Box …
…and for Engine Mounts



CS23.2400 / CS23.2440 **Powerplant Installation fire protection**

ASTM F3066 §10.1.2

For all aeroplanes with engine(s) embedded in the fuselage or in pylons on the aft fuselage […], fire extinguishing systems must be installed and compliance shown with the following […]

CS 23.1195

For commuter category aeroplanes, fire-extinguishing systems must be installed and compliance shown with the following […]

Fire estinguisher integration is really invasive…

VA-EASA discussion in progress

CASSIO 330

Further Points to discuss

- **CS 23.2225** Component Loading Conditions → Assumption for Load calculation on **three surfaces A/C**: neither CS-23 Amdt 4 (23.301(b) and 23.302) nor ASTM F3114 cover this specific configuration

CS 23.301 Loads
[….]
(b) […] Methods used to determine load intensities and distribution on canard and tandem wing configurations must be validated by flight test measurement unless the methods used for determining those loading conditions are shown to be reliable or conservative on the configuration under consideration.
[…]

CS 23.302 Canard or tandem wing configurations

The forward structure of a canard or tandem wing configuration must –
(a) Meet all requirements of subpart C and subpart D of CS-23 applicable to a wing; and
(b) Meet all requirements applicable to the function performed by these surfaces.

From **ASTM F3114-19**

4.6 Canard or Tandem Wing Configurations:

4.6.1 The forward structure of a canard or tandem wing configuration must:

4.6.1.1 Meet all requirements of this standard, Specifications F3116/F3116M, F3093/F3093M, F3083/F3083M, and F3115/F3115M applicable to a wing; and

4.6.1.2 Must meet all requirements applicable to the function performed by these surfaces.

CONCLUSIONS

- Novel aspects in Hybrid Propulsion push the A/C manufacturer towards new challenges
- New regulation approach “no more prescriptive”, open the path to guarantee an adequate level of safety in the NG General Aviation
- Definition of appropriate MoC “no straightforward” → consensus standards provide means but not the only means
- Open discussion and close cooperation with the Agency → the goal is common

…a good relationship of trust with EASA is a PARAMOUNT !!!

Certification Conference

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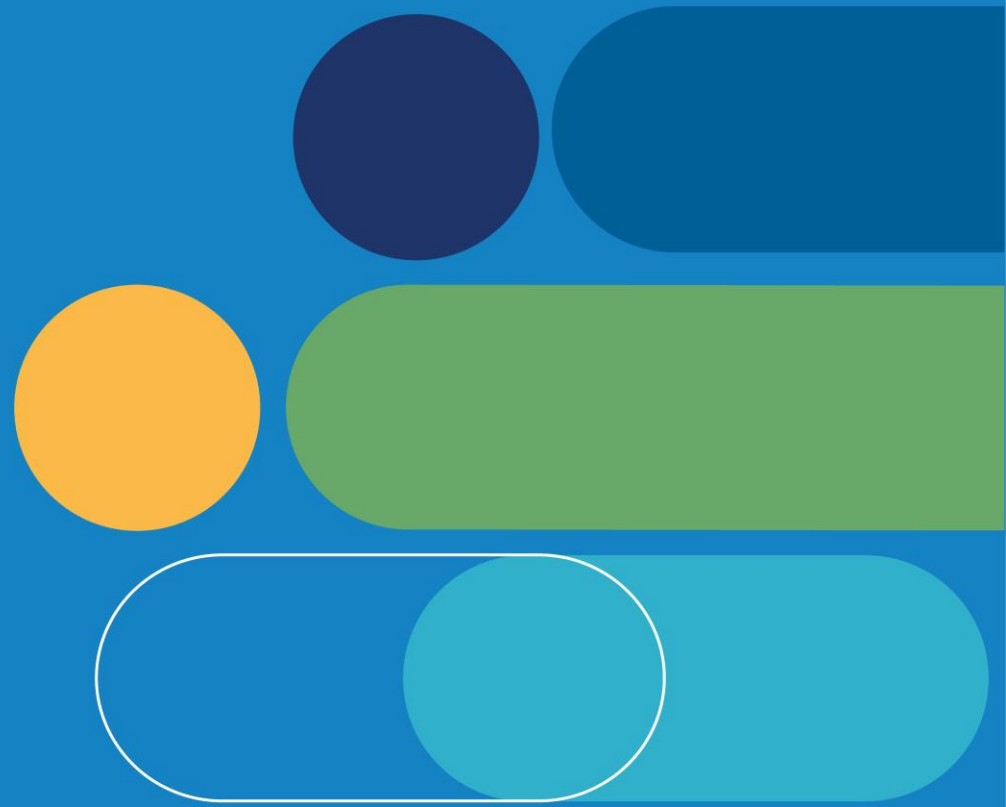
Thank you!



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