



Alliance for Zero-Emission Aviation

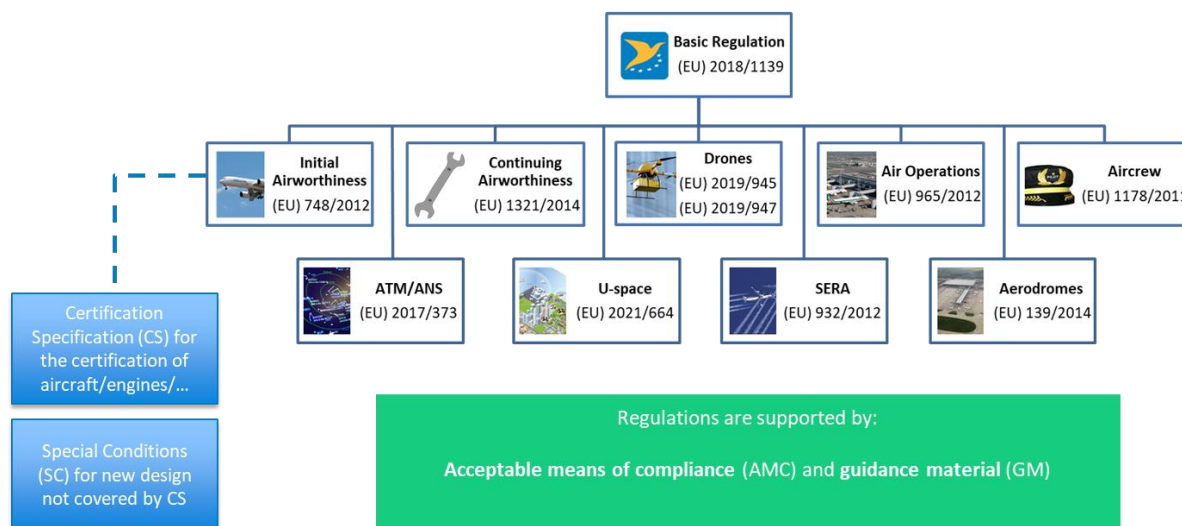
Working Group 4

Current aviation regulatory landscape for aircraft
powered by hydrogen or electric propulsion

28th March 2023

Introduction

The purpose of this document is to describe the activities that EASA is doing to adapt the aviation regulatory framework to facilitate the entry into the market of aircraft that use electric or hydrogen propulsion. The EASA aviation regulatory framework is depicted below.



Note: Certification Specifications are also applicable for aerodrome (CS-ADR) and heliport (CS-HPT) design

Throughout this process the Agency is ensuring that regulations are neutral with regards to new propulsion technologies, such that there are no barriers for zero emission aircraft to enter the market.

When it comes to propulsion systems, the aviation regulatory framework contained in some domains direct links to fuel and combustion engines. Therefore, changes were necessary to introduce alternative means of propulsion such as electric or hydrogen. Furthermore, new certification specifications are being developed to define the safety objectives that new propulsion systems must achieve.

Overall, the regulatory changes are more advanced when it comes to the introduction of electric propulsion. The first small aircraft type model with fully electric propulsion system, the Pipistrel Velis Electro, was EASA type-certificated on 15 June 2020. EASA has received several applications for type certification of Vertical Take Off and Landing aircraft (VTOL) and small airplanes equipped with electrical propulsion systems under the scope of CS-23 as well as electric engines.

As it concerns hydrogen-powered technologies, the Agency has started with creating a roadmap to build up competency in this domain, to be able to support industry requests. The Agency has received applications for CS-23 aircraft powered by hydrogen.

A summary of the regulatory landscape for zero emission aircraft is included in [Annex 1](#).

Furthermore, to support the introduction of disruptive technologies or innovative concepts (including ground and air operations) or products, whose feasibility may need to be confirmed, and for which an adequate regulatory framework does not yet exist or is not mature, the Agency is engaging with future applicants through **Pre-Application Service Contracts**. You can find more information [here](#).

At the same time, the Agency is involved in research projects regarding the environmental benefits and the certifiability of proposed designs for aircraft propulsion systems with integrated hybrid/electric engines and various power generation architectures.

With performance-based regulations there is a higher need for supporting industry standards for regulatory compliance and interoperability. Industry standards play therefore a critical role in providing means of compliance for disruptive technologies.

Initial Airworthiness (IAW)

Regulation (EU) 748/2012 (also known as Part 21) contains technical requirements and administrative procedures for the airworthiness and environmental certification of products and parts. These requirements are complemented by certification specifications for each product category.

The Agency prescribes special detailed technical specifications, named *special conditions*, for a product if the related certification specifications do not contain adequate or appropriate safety standards for the product because:

- the product has novel or unusual design features relative to the design practices on which the applicable certification specifications are based;
- the intended use of the product is unconventional; or
- experience from other similar products in service or products having similar design features or newly identified hazards have shown that unsafe conditions may develop.

Special conditions contain such safety standards as the Agency finds necessary to establish a level of safety equivalent to that of the applicable certification specification.

Once the Agency gathers sufficient experience on the airworthiness of products for which it has prescribed special conditions it develops new or amends existing Certification Specifications.

Electric and hybrid propulsion Systems (EHPS)

The existing set of certification specifications for engines (CS-E) is not suitable for the certification of Electric and Hybrid Propulsion Systems and thus specific Special Conditions have been published.

EASA has developed a dedicated set of Special Conditions (SCs), which are being applied together with existing certification specifications (CS-E, CS-23, CS-27, etc.) for the certification of aircraft with electric and hybrid propulsion on a case-by-case basis for each intended application. Additional actions will be included in the European Plan for Aviation Safety (EPAS) once enough experience has been gained on the use of certification Special Conditions (SCs).

The new special conditions are performance-based, non-prescriptive and technology agnostic to facilitate the introduction of new propulsion systems. The same philosophy has been applied to the SCs for VTOL-capable aircraft and the update of CS-23.

SC for Electric and Hybrid Propulsion Systems

In order to enable standardised type certification of Electric and Hybrid Propulsion Systems (EHPS¹), either in the case of having a separate engine type certificate (TC) for the EHPS, or in the case where the EHPS would be integrated into the aircraft TC, a set of technical specifications have been established in a dedicated SC for EHPS.

¹ 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 subsystems 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.

The proposed [SC E-19](#) was published in April 2021. SC E-19 requires the intended aircraft application to be known for the certification of the EHPS because safety objectives are derived from the aircraft safety objectives. It is technology agnostic and applies to CS-23, CS-25, CS-27, CS-29 and VTOL aircraft. SC E-19 is not applicable to hydrogen propulsion systems, to propeller or aircraft rotors or to EHPS that are not used to produce lift, thrust, or power for flight sustentation.

While SC E-19 supports on-going certification projects, it excludes the stand-alone certification of generic EHPS products without a known intended aircraft application. This may limit, for the moment, business development such as retrofit solutions to change from combustion engine to greener propulsion systems.

The possibility to further define EHPS requirements will continue to be studied in 2023 with the objective of confirming the industry need for a two-step approach that could include a publication containing:

- 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 aircraft application and ensure consistency between aircraft requirements and EHPS requirements.

Means of compliance can be adapted for each technical aspect (e.g., electric engine, fan, high voltage, etc.) and configuration and thus are proportionate to the product. Inputs are taken from acceptable means of compliance to CS-E, Certification Memoranda, Certification Review Items as well as appropriate industry standards (ASTM, SAE, EUROCAE, etc.). The development of industry standards is therefore key for the demonstration of compliance.

The means of compliance (MoC) documentation follows a 3-level approach:

- The **level 1** documentation includes a tool for applicants to identify the appropriate guidance according to their design. A matrix is available to link all requirements with available MoC. This is known as 'à la carte' concept.
- In addition, EASA will publish a **level 2** document for each requirement to explain how to use recognised standards and guidance material to demonstrate compliance. These documents will be published for public consultation.
- In a **level 3** document, EASA will provide methods of compliance, that will include documents published by standard development organisations as well as existing or new guidance material, certification memoranda, etc.

In addition to CS E-19, the following special conditions are being applied to certify electric propulsion systems in other products, such as:

Sailplanes

- 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.

Light Sport Aircraft

- 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.

Normal Category Airplanes (up to level 1²)

- SC E-18 issue 2 - Electric Propulsion Units for CS-23 Normal-Category Airplanes up to Level 1 (the aim is to make use of ASTM F3338-18 to have a joined approach with the FAA).

Certification approach

The Electric and Hybrid Propulsion System (EHPS) are stretching the boundaries of a traditional engine type certificate. 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 not be possible to set practical product boundaries.

Within this context, EASA's approach is to offer maximum flexibility to address these innovative concepts while remaining, at the same time, within the current EU legal framework.

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 according to regulation 2018/1139;
- 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 the 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). This approach needs further work before being adopted by EASA.

Hydrogen propulsion

EASA was a member of the Energy Supply Device Aviation Rulemaking Committee (ARC), who produced a [report](#), dated 8th December 2017, providing recommendations that may be used to develop appropriate airworthiness standards and guidance material with a focus on hydrogen fuel cells. This document provides a solid basis going forward on which any special condition can be based.

Since this ARC, EASA has developed further its understanding through membership of Standardisation Working groups (e.g., Eurocae WG80 on Hydrogen Fuel Cell Systems), engaging with industry through Innovative Partnership Contracts, and through early applications for Type Certification. These activities have allowed EASA to review and identify where there is the need for existing requirements to evolve to sufficiently address hydrogen as the energy carrier onboard aircraft.

Future Hydrogen Special Conditions

EASA is now in the position to start drafting special conditions to cover the configurations of the early TC applicants. These are expected to be developed through 2023 with a target to publish for consultation before year end.

² airplanes with a maximum seating configuration of 0 to 1 passengers

Environmental Protection (ENV)

When directly applicable, Environmental Protection (EP) requirements are established in ICAO Annex 16 and cross-referenced in the EASA Basic Regulation and Part 21. For products for which ICAO Annex 16 does not apply, EASA Basic Regulation allows establishing dedicated EP requirements.

Noise

The noise requirements of electrically powered light propeller aircraft have been shown so far to be properly captured by Chapter 10 of ICAO Annex 16, as was the case for the noise certification of the Pipistrel Velis Electro 128, which only warranted small adaptations to the noise measurement procedures.

As regards novel products for Urban Air Mobility (UAM), such as eVTOL aircraft, EASA is building project-specific noise requirements that will undergo public consultation, until the point when enough applications provide sufficient experience for EASA to develop generic noise requirements.

Emissions

Emissions are not a concern for electric aircraft. When it comes to emissions from hydrogen propulsion, a distinction must be made between hydrogen burning engines (hydrogen combustion) and fuel cell powered electrical motors. The latter will not emit any emissions other than water.

When considering combustion of hydrogen we can expect that there will not be any considerable amounts of hydrocarbons, carbon monoxide or particulate emissions coming from the fuel (hydrogen) as it does not contain any carbon. Emissions from lubrication oil are a source of particle emissions, as in current jet engines and should be considered during engine emissions tests. NO_x emissions can be a challenge which requires further investigation.

The combustion temperatures from hydrogen are higher and therefore the NO_x emissions are potentially higher. On the other hand hydrogen can be combusted in leaner mixtures which offers the potential to reduce NO_x even below current levels of kerosene combustors.

However, these kind of low NO_x hydrogen combustion systems are only available as laboratory systems and still need some time to be developed to a combustor to be certified.

Regarding measurement and sampling there are most likely to be some modifications required to account for the wet conditions of the exhaust and its effect on the analysers. Further on, the methods of correction to reference conditions need to be modified to reflect the difference in the combustion equations.

SAE E31 who is providing technical input to ICAO CAEP WG3 has a working item to consider these questions.

Water vapour is a by-product of all hydrogen usage (whether by combustion or fuel cell). There are some general considerations regarding hydrogen which are the potential increase of contrail formation from flying the aircraft and the unavoidable leaks/vents of gaseous hydrogen from the tanks of parked aircraft.

ICAO's involvement would be required in relation to environmental standards, particularly for non-CO₂ emissions such as NO_x and water. The importance of limits on these emissions is still subject to significant research and may become a political issue.

The significance of non-CO₂ climate impacts from aviation activities, are at least as important in total as those of CO₂ alone, however based on scientific assessments, uncertainties from the overall non-CO₂ effects are eight times larger than those from CO₂, and the overall confidence levels of the largest non-CO₂ effects (e.g. contrails) are considered 'low'³. Beyond the fundamental science, the key challenge on the non-CO₂ issue lies in the need to be able to clearly demonstrate that any recommendation on measures (emission requirements, policies, incentives, etc.) results in proportionate environmental benefits, are politically, technically and administratively feasible and do not have perverse outcomes (e.g., design trade-offs, policy measure based on incorrect assumptions). There are many key uncertainties remaining in the quantification of non-CO₂ effects from aviation environmental impact assessment capabilities (e.g., atmospheric modelling/prediction, CO₂ equivalence metrics, time horizons). Addressing these elements is critical for robust impact assessments (e.g., costs, benefits, trade-offs, implementation challenges) to ensure 'no regret' options are addressed when introducing electric/hydrogen aircraft into the aviation system.

Continuing airworthiness (CAW)

Electric and hybrid propulsion

When the Continuing Airworthiness (CAW) regulation (EU 1321/2014) was developed, electrical propulsion was not considered. The rule therefore contained gaps that are now being bridged to create a rule framework that would cover also electrical propulsion.

Such gaps can be summarised as follows:

- with regards to the possible scope of approval for maintenance organisations, for the class 'engine', there is no adequate rating for electrical engines, since the only possible ratings are: turbine, piston and APU. The same scenario applies with the choices for the scope of approval of training organisations subject to Part-147.
- When it comes to the full aircraft, considering the title of the Part-66 licenses for maintenance certifying staff on categories A, B1 and B3, these are not suitable for electrical aeroplanes or helicopters. Therefore, electrical propulsion is not considered in the Part 66 basic knowledge syllabus, except only for the L2 license that applies to gliders and aeroplanes with Maximum Take off Mass (MTOM) below 1200 Kg.
- Electrical engine aircraft are also not considered when establishing the training levels for each aircraft type in Appendix III of Part 66.

In addition, the rule contains provisions which were introduced with the intention to alleviate small aircraft from compliance with more stringent requirements. These alleviations were introduced by applying them to piston-engine aircraft but could have also been made applicable to electrically driven small aircraft. An example could be the possibility for an independent Part-66 license holder (i.e., working outside an approved organisation) to release to service some maintenance tasks on an ELA1⁴ with a piston-engine.

³ [Updated analysis of the non-CO₂ climate impacts of aviation and potential policy measures pursuant to EU Emissions Trading System Directive Article 30\(4\) - Report from the Commission to the European Parliament and the Council | EASA \(europa.eu\)](#)

⁴ ELA1 aircraft' means the following manned European Light Aircraft:

- 1) an aeroplane with a Maximum Take-off Mass (MTOM) of 1 200 kg or less that is not classified as complex motor-powered aircraft;

Any potential need for adaptation of the rule to electric propulsion aircraft is already addressed in the scope of the ongoing RMT.0731 (adapting CAW rules to 'new air mobility') which aims to be technology neutral. An NPA was published in 2021 ([NPA 2021-15](#)).

In the Part-66 licensing system, new training and experience requirements are being proposed that would entitle maintenance certification rights for these new categories of aircraft. Ongoing regulatory activities are taking into consideration comments received during the consultation of [NPA 2021-15](#). The current line of thought is to propose to address the above regulatory gaps:

- by creating a new license category for small electrical airplanes;
- for other aircraft outside the current Part-66 categories, by permitting the endorsement of aircraft types that are not covered by the current Part-66, on one of the existing Part-66 license categories by focusing on the training of the aircraft being endorsed, and the scope of this training controlled using the Operational Suitability Data (OSD) concept. This strategy would also be applied for aircraft types with a powerplant that was also not addressed with the current Part-66 system, for instance large airplanes with electrical powerplants based on fuel cells or hybrid powerplants.

Hydrogen propulsion

The rule would not require adaptation because of the use of hydrogen instead of other traditional aviation fuels if the aircraft category and powerplant would fit into the current Part-66 system. Note that the fact that the rule would not require adaptation in this regard does not mean that there is no impact on related stakeholders since they would need different training of personnel, company procedures, dedicated premises, etc. for being recognised for these novelties.

Air Operations (OPS)

Electric and hybrid propulsion

The existing Air Operations regulation (EU 965/2012) covers operations of airplanes, helicopters, sailplanes and balloons. The Air Operations regulation's baseline is currently aircraft using propulsion systems based on hydrocarbon fuels. However, extensive work is already being done to accommodate new sources of energy.

All the implementing rules related to fuel/energy, have been modified with the adoption of Regulation (EU) 2021/1296, and for non-commercial operations (Part-NCO⁵), both the implementing rules and AMC and GM are now fitted for other forms of energy. This process was carried out as part of facilitating the entry of Pipistrel and other electric aircraft into the European market.

For other types of operations (e.g., commercial air transport, non-commercial operation with complex motor-powered aircraft⁶, etc.), although the implementing rules already allow other forms of energy,

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- 2) a sailplane or powered sailplane of 1 200 kg MTOM or less;
 - 3) a balloon with a maximum design lifting gas or hot air volume of not more than 3 400 m³ for hot air balloons, 1 050 m³ for gas balloons, 300 m³ for tethered gas balloons;
 - 4) an airship designed for not more than 4 occupants and a maximum design lifting gas or hot air volume of not more than 3 400 m³ for hot air airships and 1 000 m³ for gas airships;

⁵ Different set of technical rules apply for air operations (e.g., CAT, NCC, NCO, SPO operations), considering the principle of proportionality and the need to have different safety levels. You can find more information [here](#).

⁶ 'complex motor-powered aircraft' is

additional rulemaking work must be carried out to accommodate acceptable means of compliance and guidance material that would describe the operations of such new propulsion systems. On this matter (to progress the rulemaking activities), EASA is waiting for the industry to complete a suitable concept of operations to develop rules accordingly. Therefore, operations with electric or hybrid propulsion in commercial air transport do not fit in the regulation, and only non-commercial other than complex motor power aircraft rules are ready.

Furthermore, current rules not only focus on above mentioned aircraft categories but also on the traditional powerplant categories (piston engine, turboprop, turbofan and turboshaft). Consequently, these rules focus on the performances, equipment and instruments associated to those categories of aircraft and powerplants. However, electric or hybrid propulsion are not only new propulsion systems, but these new systems can also be expected to be associated in many cases with new aircraft configurations (linked, for example, to a distributed power) with different performances and potentially higher levels of automation compared to the traditional aircraft categories addressed in the rules.

[NPA 2022-06](#) proposed operational requirements applicable to manned VTOL-capable aircraft. A new Annex IX (Part-IAM) to Commission Regulation (EU) No 965/2012 specifically considers VTOL-capable aircraft with electric propulsion although it is also applicable to aircraft with other sources of energy (e.g., hybrid). The main concerns that have been addressed relate to flight routes, aerodromes, usable energy and energy reserves. Examples of operational requirements amended are charging of batteries and fueling/defueling

Hydrogen propulsion

In lack of an operational concept on how to operate commercial aircraft with hydrogen, the operational rules would in principle be suitable. However, operational procedures like refueling with passengers on board or engine running will not be allowed until AMC are developed for such a purpose by operators and competent authorities

Aircrew

Electric and hybrid propulsion

The requirements of Annex I (Part-FCL) to Commission Regulation (EU) No 1178/2011 apply only to aircraft with '*piston*' and '*turbine*' propulsion, and at the moment do not include 'electric' propulsion. The Part-FCL requirements were therefore not fit for the pilots intending to obtain privileges for the Pipistrel Virus Electro with an electric engine.

National authorities had therefore to issue exemptions to adequately address the needs of pilots, training organisations and instructors and examiners intending to operate the Pipistrel Virus Electro. Under these exemptions those pilots, training organisations and instructors and examiners were permitted, by derogation from Part-FCL, to operate that aircraft in Visual Flight Rules (VFR) under the

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- 1) an aeroplane with a maximum certificated take-off mass exceeding 5 700 kg, or certificated for a maximum passenger seating configuration of more than nineteen, or certificated for operation with a minimum crew of at least two pilots, or equipped with (a) turbojet engine(s) or more than one turboprop engine, or
 - 2) a helicopter certificated for a maximum take-off mass exceeding 3 175 kg, or for a maximum passenger seating configuration of more than nine, or for operation with a minimum crew of at least two pilots, or
 - 3) a tilt rotor aircraft;

existing single-engine piston (SEP) airplane class ratings. In order to ensure safety and compliance with the essential requirements for aircrew mitigating measures had to be introduced.

The exemptions bridge the regulatory gap until the introduction of aircrew licensing requirements for aircraft with electric propulsion. RMT.0678 addresses electrical motor without reference to battery or fuel cells. An AMC for battery powered has been developed, however for fuel cells would need to be added later. An EASA opinion is planned for 2023. There are no proposals to amend the air crew regulation to cover distributed propulsion systems.

In addition, the new innovative aircraft (eVTOL), regarding its handling characteristics, cannot be compared to aircraft regulated today in Regulation (EU) No 1178/2011. Today's conventional aircraft are operated by direct control of dedicated parts of the propulsion system or the airframe (e.g. propeller/rotor blade angles and revolutions per minute (RPM), aileron, rudder, elevator, flaps). eVTOLs will however be operated through simple control inputs ('up', 'down',...) to the aircraft automation system in order to make aircraft perform horizontal or vertical movements.

The aircraft's automation system (computer) translates this pilot input into actions of the propulsion system (RPM adjustments, vector-thrust engines/rotors movements). In simple words: Flying these innovative aircraft is closer to a computer game ('fly-by-computer') than to flying today's conventional aircraft (mechanical input / 'fly-by-wire').

This completely different way to operate aircraft requires significant changes to pilot training, testing and checking.

Some of these regulatory challenges will be addressed through RMT.0230 which aims at introducing a new type of pilot licence (VTOL-capable aircraft pilot licence – VPL) in Regulation (EU) No 1178/2011. The VPL will follow an innovative and also competency-based training concept which will be flexible to address a variety of different eVTOL aircraft with different propulsion systems and automation capabilities. According to the current planning, a notice of proposed amendment (NPA) is planned to be published at the end of 2024.

For the initial phase of eVTOL aircraft operation, EASA has already proposed transitional provisions to allow holders of commercial pilot licences for aeroplanes or helicopters to obtain an additional type rating for an eVTOL aircraft (see [NPA 2022-06](#)). A final EASA Opinion is planned to be published and forwarded to the European Commission for adoption still in the course of 2023.

Hydrogen propulsion

Current rule changes refer to single-engine single-pilot airplanes with electric engines or “hybrid” engines⁷. Acceptable Means of Compliance (AMC) have been drafted to cover electric engines powered by batteries. Nothing has been drafted yet to specifically address hydrogen, neither at regulation nor at AMC level.

⁷ “hybrid” means an engine system, comprising a thermal and an electric engine which together power on single propeller

Air Traffic Management (ATM)

Electric and hybrid propulsion

EASA is also progressively introducing reference to the term ‘energy’ aside to the term ‘fuel’, to reflect the progressive introduction of electrically powered aircraft in the air traffic management related regulations.

The term ‘fuel’ appears in a significant number of provisions within the Standardised European Rules of the Air (SERA). With the introduction of manned VTOL-capable aircraft, which are generally electrically powered, the issue was raised and discussed to determine the best manner to reflect the actual situation of these new aircraft regarding the fuel status. Several options were envisaged like the juxtaposition of the terms ‘fuel’ and ‘energy’, or a modification of the definition of ‘fuel’ to also include energy, as it is envisaged by ICAO in some cases⁸. Due to the use of the term ‘fuel’ in other applicable aviation regulations, it was proposed in [NPA 2022-06](#) that the terms ‘fuel/energy’ would be used whenever appropriate, but the term ‘fuel’ would be retained when necessary, in particular in sentences that contain standardised phraseology.

No amendment to existing requirements concerning air-ground communications and phraseologies will be introduced in SERA on this subject, waiting for related global harmonisation initiatives from ICAO.

When it comes to Air Traffic Controller’s (ATCO) training (Regulation EU 2015/340), training subjects, topics, subtopics and training objectives are defined in a manner that already accommodates the introduction of contents on fuel-related aspects of electrically powered aircraft. This is also the case for the use of phraseologies (even if at the moment the term ‘energy’ will not be explicitly included in the SERA standard phraseologies). EASA will however propose specific amendments to the actual ATCO initial training on the characteristics of aircraft hybrid and electric propulsion. An NPA is expected to be published this year.

Hydrogen propulsion

Even though a detailed assessment on the potential impact of the introduction of hydrogen in the ATM regulatory framework has not been done, the above approach applies also to hydrogen propulsion.

Aerodromes (ADR)

Regulation (EU) 139/2014 on Aerodromes contains Authority Requirements (Part-ADR.AR), Organisation Requirements (Part-ADR.OR) and Operations Requirements (Part-ADR.OPS). The implementing rules contained in Part-ADR.OPS regarding fueling activities are high level, so only limited changes are anticipated for the introduction of zero emission aircraft. Apart from that, EASA is currently developing a Ground Handling (GH) regulation (RMT.0728), where the objective is to keep the rules as far as possible technology neutral, in order to cater for aircraft powered by hydrogen-and electric propulsion. An opinion proposing ground handling requirements is planned for Q2 2023.

⁸ Draft ICAO Annex 6 Part IV point 4.3.6 (version G of September 2020) proposes the addition of the following: ‘Note — For the remainder of this Part of this Annex, the term ‘fuel’ is intended to include all sources of energy for RPA, to include (but not limited to) petroleum based, solar, battery or any future source that provides energy to the Remote Pilot Aircraft.’

Electric and hybrid propulsion

Requirements to cover rescue and firefighting on aerodromes regarding electric and hybrid powered aircraft, battery storage and dispensing are required and should be provided, mainly at AMC and GM level.

Additional awareness for authorities and training and proficiency checks for aerodrome operators' staff will be needed.

In addition, the Agency has developed [prototype technical specifications for the design of vertiports](#) to support flight operations with VTOL aircraft.

Hydrogen propulsion

An implementing requirement mirroring the “*Aircraft refueling*” requirements (ADR.OPS.D.060) will probably need to be developed for hydrogen to support standardisation of developed practices (e.g., on hydrogen refilling operations). Just drafting a technology neutral rule will probably not be enough as a solution. For doing so, the Agency mainly depends on the development of a hydrogen ground operation concept. It is unclear how the aircraft will be designed and how the filling of the tanks will take place, as there is no concept for this yet. The implementing rule on “*fuel quality*” (ADR.OPS.B.055) is not specific for conventional fuel and is therefore no hinderance for hydrogen introduction.

In addition to ensuring safety, refueling operation practices (and hydrogen storage at aerodromes) must ensure leak minimisation to preserve the overall environmental performance of hydrogen aircraft.

Similarly for the Certification Specifications (CS) on ADR infrastructure, there may be an impact on the minimal required clearance distances on aircraft stands (CS ADR-DSN.E.365). Especially for hydrogen it is unclear if the currently defined clearance distances on stands will be taken as a design value for the developments of the new hydrogen concepts, or if they might need to be increased for these operations.

Additional requirements to cover rescue and firefighting requirements and emergency response planning on aerodromes will be needed for hydrogen aircraft concepts. The prevention of hydrogen fires and the tactical planning of an adequate response might even require a large shift in paradigm compared to conventional rescue operations.

Additional awareness for authorities and training and proficiency checks for aerodrome operators' staff will be needed.

Annex 1 – Summary of regulatory landscape for zero emission aircraft

Prop. Tech.	IAW	ENV	CAW	OPS	Air Crew	ATM	ADR
Electric	Special Conditions available for all products. Means of Compliance under development	ICAO A16 noise requirements suitable for small electric aircraft. Developing project specific noise requirements for eVTOL.	New training requirements in Part 66 licensing system are being proposed <i>(RMT.0731)</i>	Rule modified to allow other forms of energy <i>(Reg EU 2021/1296)</i> AMC & GM updated for NCO, but not yet for other types of operation. Rules being adapted for VTOL-capable aircraft.	Licensing requirements for a/c with electric propulsion under development <i>(RMT.0678)</i> AMC for battery powered aircraft developed. New VTOL-capable aircraft pilot license – VPL <i>(RMT.0230)</i>	SERA modified to allow other forms of energy <i>(RMT.0230)</i> SERA communications and phraseologies awaiting ICAO work ATCO initial training being amended <i>(RMT.0668)</i>	Technology neutral GH Opinion under development <i>(RMT.0728)</i> AMC & GM needed to address recuse and firefighting of electric a/c. Technical specifications for the design of vertiports available. IR and CS will need to be adapted for a/c refueling with H2. Requirements for rescue and firefighting and emergency response planning to be developed.
H2	Special Conditions not yet available	Emissions from electric a/c or fuel cells not a concern Non-CO ₂ emission (NO _x and H ₂ O) subject to research.		AMC & GM not available to address refueling with passengers on-board or engine running.	Regulation yet to be adapted for H2.		