Special Conditions 3, 7, and 8 are self-explanatory.

Special Condition 4 clarifies that the flammable-fluid fire-protection requirements of § 25.863 apply to rechargeable lithium battery installations. § 25.863 is applicable to areas of the airplane that could be exposed to flammable fluid leakage from airplane systems. Rechargeable lithium batteries contain electrolyte that is a flammable fluid.

Special Condition 5 requires each rechargeable lithium battery and battery system installation to not damage surrounding structure or adjacent systems, equipment, or electrical wiring from corrosive fluids or gases that may escape in such a way as to cause a major or more severe failure condition.

Special Condition 6 requires each rechargeable lithium battery and battery system installation to have provisions to prevent any hazardous effect on airplane structure or systems caused by the maximum amount of heat it can generate due to any failure of it or its individual cells. The means of meeting special conditions 5 and 6 may be the same, but they are independent requirements addressing different hazards. Special Condition 5 addresses corrosive fluids and gases, whereas special condition 6 addresses heat.

Special Condition 9 requires rechargeable lithium batteries and battery systems to have ''automatic'' means, for charge rate and disconnect, due to the fast-acting nature of lithium battery chemical reactions. Manual intervention would not be timely or effective in mitigating the hazards associated with these batteries.

These special conditions apply to all rechargeable lithium batteries and battery system installations in lieu of § 25.1353(b)(1) through (4) at amendment 25–123, or § 25.1353(c)(1) through (4) at earlier amendments. Those regulations will remain in effect for other battery installations on these airplanes.

The special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

Applicability

As discussed above, these proposed special conditions are applicable to Textron Model MU–300–10, 400, and 400A airplanes. Should Textron apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, these special conditions would apply to that model as well.

Conclusion

This action affects only a certain novel or unusual design feature on Textron Model MU–300–10, 400, and 400A airplanes. It is not a rule of general applicability.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

Authority Citation

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(f), 40113, 44701, 44702, and 44704.

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for Textron Model MU–300–10, 400, and 400A airplanes.

In lieu of Title 14, Code of Federal Regulations (14 CFR) 25.1353(b)(1) through (4) at amendment 25–123 or § 25.1353(c)(1) through (4) at earlier amendments, each rechargeable lithium battery installation must:

1. Be designed to maintain safe cell temperatures and pressures under all foreseeable operating conditions to prevent fire and explosion.

2. Be designed to prevent the occurrence of self-sustaining, uncontrollable increases in temperature or pressure, and automatically control the charge rate of each cell to protect against adverse operating conditions, such as cell imbalance, back charging, overcharging, and overheating.

3. Not emit explosive or toxic gases, either in normal operation or as a result of its failure, that may accumulate in hazardous quantities within the airplane.

4. Meet the requirements of § 25.863.

5. Not damage surrounding structure or adjacent systems, equipment, or electrical wiring from corrosive fluids or gases that may escape in such a way as to cause a major or more severe failure condition.

6. Have provisions to prevent any hazardous effect on airplane structure or systems caused by the maximum amount of heat it can generate due to any failure of it or its individual cells.

7. Have a failure sensing and warning system to alert the flightcrew if its failure affects safe operation of the airplane.

8. Have a monitoring and warning feature that alerts the flightcrew when its charge state falls below acceptable levels if its function is required for safe operation of the airplane.

9. Have a means to automatically disconnect from its charging source in the event of an over-temperature condition, cell failure or battery failure.

Note: A battery system consists of the battery, battery charger and any protective, monitoring and alerting circuitry or hardware inside or outside of the battery. It also includes vents (where necessary) and packaging. For the purpose of this special condition, a battery and the battery system is referred to as a battery.

Issued in Forth Worth, Texas, on March 12, 2026.

Jorge R. Castillo,

Manager, Technical Policy Branch, AIR–620, Policy and Standards Division, Aircraft Certification Service.

[FR Doc. 2026–05264 Filed 3–17–26; 8:45 am]

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 33

[Docket No. FAA–2025–2409; Special Conditions No. 33–031–SC]

Special Conditions: ZeroAvia, Inc. Model ZA601 Electric Engines

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are issued for the ZeroAvia, Inc. (Zero Avia) Model ZA601 electric engines. These engines will have a novel or unusual design feature when compared to the state of technology envisioned in the airworthiness standards for aircraft engines. This design feature is an electrical system that will power a mechanical rotating shaft to provide propulsion for airplanes which will be certified separately from the engine. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

DATES: Effective March 18, 2026.

FOR FURTHER INFORMATION CONTACT: Mark Bouyer, Engine and Propulsion Section, AIR–625, Technical Policy Branch, Policy and Standards Division, Aircraft Certification Service, Federal Aviation Administration, 1200 District Ave. Burlington, MA 01803; telephone (781) 238–7755; email *Mark.Bouyer@faa.gov*.

SUPPLEMENTARY INFORMATION:

Background

On May 3, 2024, ZeroAvia, applied for a type certificate for its Model ZA601 electric engine. The electric engine consists of an electric motor, stator, inverters/controllers and will operate with low and high-voltage electrical systems. The ZeroAvia ZA601 electric engine will be used in airplanes certificated under 14 CFR part 23 in the normal category, level 3 and higher.

On January 6, 2026, the FAA issued the Notice of Proposed Special Conditions for the ZeroAvia electric engine, which was published in the **Federal Register** on January 8, 2026 (91 FR 633). The FAA inadvertently listed ''level 4 and higher'' in the Background Section. The FAA has corrected the Final Special Conditions to list ''level 3 and higher'' for the ZeroAvia ZA601 electric engine that will be used under 14 CFR part 23, in the normal category.

Type Certification Basis

Under the provisions of 14 CFR 21.17, ZeroAvia must show that the Model ZA601 electrical engines meet the applicable provisions of part 33, as amended by amendments 33–1 through 33–36, in effect on the date of application for a type certificate.

If the FAA finds that the applicable airworthiness regulations (*e.g.,* 14 CFR part 33) do not contain adequate or appropriate safety standards for the ZeroAvia Model ZA601 engine because of a novel or unusual design feature, the FAA prescribes special conditions under the provisions of § 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the type certificate for that model be amended later to include any other model that incorporates the same novel or unusual design feature, these special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, the ZeroAvia Model ZA601 engine must comply with the noise-certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type certification basis under § 21.17(a)(2).

Novel or Unusual Design Features

The ZeroAvia ZA601 electric engine will incorporate the following novel or unusual design feature:

An electric motor, motor controller, and high-voltage electrical system used as the primary source of propulsion for an airplane.

Discussion

Aircraft engines make use of an energy source to drive mechanical systems that provide propulsion for the aircraft. The technology that the FAA anticipated in the development of 14 CFR part 33 converts oxygen and fuel to generate energy through an internal combustion system for turning shafts attached to propulsion devices such as propellers and ducted fans.

Electric propulsion technology is substantially different from the technology used in previously certificated turbine and reciprocating engines. Therefore, these engines introduce new safety concerns that need to be addressed in the certification basis.

A growing interest within the aviation industry involves electric propulsion technology. As a result, international agencies and industry stakeholders formed Committee F39 under ASTM International, formerly known as American Society for Testing and Materials, to identify the appropriate technical criteria for aircraft engines using electrical technology that has not been previously type certificated for aircraft propulsion systems. ASTM International is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. ASTM International published ASTM F3338–18, ''Standard Specification for Design of Electric Propulsion Units for General Aviation Aircraft,'' in December 2018.[1] The FAA used the technical criteria from the ASTM F3338–18, the published Special Conditions No. 33–022–SC for the magniX USA, Inc. Model magni350 and magni650 engines, and information from the ZeroAvia Model ZA601 engine design to develop special conditions that establish an equivalent level of safety to that required by part 33.

Part 33 Was Developed for Gas-Powered Turbine and Reciprocating Engines

Energy can be generated from various sources such as petroleum and natural gas. The turbine and reciprocating aircraft engines certificated under part 33 use aviation fuel for an energy source. The reciprocating and turbine engine technology that was anticipated in the development of part 33 converts oxygen and fuel to energy using an internal combustion system, which generates heat and mass flow of combustion products for turning shafts that are attached to propulsion devices such as propellers and ducted fans. Part 33 regulations set forth standards for these engines and mitigate potential hazards resulting from failures and malfunctions. The nature, progression, and severity of engine failures are tied closely to the technology that is used in the design and manufacture of aircraft engines. These technologies involve chemical, thermal, and mechanical systems. Therefore, the existing engine regulations in part 33 address certain chemical, thermal, and mechanically induced failures that are specific to air and fuel combustion systems operating with cyclically loaded, high-speed, high-temperature, and highly stressed components.

ZeroAvia's Electric Engines Are Novel or Unusual

The existing part 33 airworthiness standards for aircraft engines date back to 1965. As discussed in the previous paragraphs, these airworthiness standards are based on fuel-burning reciprocating and turbine engine technology. The ZeroAvia Model ZA601 engines are neither turbine nor reciprocating engines. These engines have a novel or unusual design feature, which is the use of electrical sources of energy instead of fuel to drive the mechanical systems that provide propulsion for aircraft. The ZeroAvia aircraft engine is subject to operating conditions produced by chemical, thermal, and mechanical components working together, but the operating conditions are unlike those observed in internal combustion engine systems. Therefore, part 33 does not contain adequate or appropriate safety standards for the ZeroAvia Model ZA601 engine's novel or unusual design feature.

ZeroAvia's aircraft engines will operate using electrical power instead of air and fuel combustion to propel the aircraft. These electric engines will be designed, manufactured, and controlled differently than turbine or reciprocating aircraft engines. They will be built with an electric motor, motor controller, and high-voltage electrical systems that draw energy from electrical storage or electrical energy generating systems. The electric motor is a device that converts electrical energy into mechanical energy by electric current flowing through windings (wire coils) in the motor, producing a magnetic field that interacts with permanent magnets mounted on the engine's main rotor. The controller is a system that consists of two main functional elements: the motor controller and an electric power

[1] *https://www.astm.org/Standards/F3338.html.*

inverter to drive the motor.[2] The high-voltage electrical system is a combination of wires and connectors that integrate the motor and controller.

In addition, the technology comprising these high-voltage and high-current electronic components introduces potential hazards that do not exist in turbine and reciprocating aircraft engines. For example, high-voltage transmission lines, electromagnetic shields, magnetic materials, and high-speed electrical switches are necessary to use the physical properties of an electric engine for propelling an aircraft. However, this technology also exposes the aircraft to potential failures that are not common to gas-powered turbine and reciprocating engines, technological differences which could adversely affect safety if not addressed through these special conditions.

ZeroAvia's Electric Engines Require a Mix of Part 33 Standards and Special Conditions

Although the electric aircraft engines ZeroAvia use a novel or unusual design feature that the FAA did not envisage during the development of its existing part 33 airworthiness standards, these engines share some basic similarities, in configuration and function, to engines that use the combustion of air and fuel, and therefore require similar provisions to prevent common hazards (*e.g.,* fire, uncontained high energy debris, and loss of thrust control). However, the primary failure concerns and the probability of exposure to these common hazards are different for the ZeroAvia Model ZA601 electric engine. This creates a need to develop special conditions to ensure the engine's safety and reliability.

The requirements in part 33 ensure that the design and construction of aircraft engines, including the engine control systems, are proper for the type of aircraft engines considered for certification. However, part 33 does not fully address aircraft engines like the ZeroAvia Model ZA601, which operates using electrical technology as the primary means of propelling the aircraft. This necessitates the development of special conditions that provide adequate airworthiness standards for these aircraft engines.

The requirements in part 33, subpart B, are applicable to reciprocating and turbine aircraft engines. Subparts C and D are applicable to reciprocating aircraft engines. Subparts E through G are applicable to turbine aircraft engines. As such, subparts B through G do not adequately address the use of aircraft engines that operate using electrical technology. Special conditions are needed to ensure a level of safety for electric engines that is commensurate with these subparts, as those regulatory requirements do not contain adequate or appropriate safety standards for electric aircraft engines that are used to propel aircraft.

FAA Special Conditions for the ZeroAvia Engine Design

Applicability: Special condition no. 1 requires ZeroAvia to comply with part 33, except for those airworthiness standards specifically and explicitly applicable only to reciprocating and turbine aircraft engines.

Engine Ratings and Operating Limitations: Special condition no. 2, in addition to compliance with § 33.7(a), requires ZeroAvia to establish engine operating limits related to the power, torque, speed, and duty cycles specific to ZeroAvia Model ZA601 electric engines. The duty or duty cycle is a statement of the load(s) to which the engine is subjected, including, if applicable, starting, no-load and rest, and de-energized periods, including their durations or cycles and sequence in time. This special condition also requires ZeroAvia to declare cooling fluid grade or specification, power supply requirements, and to establish any additional ratings that are necessary to define the ZeroAvia Model ZA601 electric engine capabilities required for safe operation of the engine.

Materials: Special condition no. 3 requires ZeroAvia to comply with § 33.15, which sets requirements for the suitability and durability of materials used in the engine, and which would otherwise be applicable only to reciprocating and turbine aircraft engines.

Fire Protection: Special condition no. 4 requires ZeroAvia to comply with § 33.17, which sets requirements to protect the engine and certain parts and components of the airplane against fire, and which would otherwise be applicable only to reciprocating and turbine aircraft engines. Additionally, this special condition requires ZeroAvia to ensure that the high-voltage electrical wiring interconnect systems that connect the controller to the motor are protected against arc faults. An arc fault is a high-power discharge of electricity between two or more conductors. This discharge generates heat, which can break down the wire's insulation and trigger an electrical fire. Arc faults can range in power from a few amps up to thousands of amps and are highly variable in strength and duration.

Durability: Special condition no. 5 requires the design and construction of ZeroAvia Model ZA601 electric engines to minimize the development of an unsafe condition between maintenance intervals, overhaul periods, and mandatory actions described in the instructions for continued airworthiness (ICA).

Engine Cooling: Special condition no. 6 requires ZeroAvia to comply with § 33.21, which requires the engine design and construction to provide necessary cooling, and which would otherwise be applicable only to reciprocating and turbine aircraft engines. Additionally, this special condition requires ZeroAvia to document the cooling system monitoring features and usage in the engine installation manual (see § 33.5) if cooling is required to satisfy the safety analysis described in special condition no. 17. Loss of cooling to an aircraft engine that operates using electrical technology can result in rapid overheating and abrupt engine failure, with critical consequences to safety.

Engine Mounting Attachments and Structure: Special condition no. 7 requires ZeroAvia and the design to comply with § 33.23, which requires the applicant to define, and the design to withstand, certain load limits for the engine mounting attachments and related engine structure. These requirements would otherwise be applicable only to reciprocating and turbine aircraft engines.

Accessory Attachments: Special condition no. 8 requires the design to comply with § 33.25, which sets certain design, operational, and maintenance requirements for the engine's accessory drive and mounting attachments, and which would otherwise be applicable only to reciprocating and turbine aircraft engines.

Overspeed: Special condition no. 9 requires ZeroAvia to establish by test, validated analysis, or a combination of both, that—

(1) the rotor overspeed must not result in a burst, rotor growth, or damage that results in a hazardous engine effect;

(2) rotors must possess sufficient strength margin to prevent burst; and

(3) operating limits must not be exceeded in service.

The special condition associated with rotor overspeed is necessary because of the differences between turbine engine technology and the technology of these electric engines. Turbine rotor speed is driven by expanding gas and aerodynamic loads on rotor blades. Therefore, the rotor speed or overspeed

[2] Sometimes the entire system is referred to as an inverter. Throughout this document, it is referred to as the controller.

results from interactions between thermodynamic and aerodynamic engine properties. The speed of an electric engine is directly controlled by electric current, and an electromagnetic field created by the controller. Consequently, electric engine rotor response to power demand and overspeed-protection systems is quicker and more precise. Also, the failure modes that can lead to overspeed between turbine engines and electric engines are vastly different, and therefore this special condition is necessary.

Engine Control Systems: Special condition no. 10(b) requires ZeroAvia to ensure that these engines do not experience any unacceptable operating characteristics, such as unstable speed or torque control, or exceed any of their operating limitations.

The FAA originally issued § 33.28 at amendment 33–15 to address the evolution of the means of controlling the fuel supplied to the engine, from carburetors and hydro-mechanical controls to electronic control systems. These electronic control systems grew in complexity over the years, and as a result, the FAA amended § 33.28 at amendment 33–26 to address these increasing complexities. The controller that forms the controlling system for these electric engines is significantly simpler than the complex control systems used in modern turbine engines. The current regulations for engine control are inappropriate for electric engine control systems; therefore, special condition no. 10(b) associated with controlling these engines is necessary.

Special condition no. 10(c) requires ZeroAvia to develop and verify the software and complex electronic hardware used in programmable logic devices, using proven methods that ensure that the devices can provide the accuracy, precision, functionality, and reliability commensurate with the hazard that is being mitigated by the logic. RTCA DO–254, ''Design Assurance Guidance for Airborne Electronic Hardware,'' dated April 19, 2000,[3] distinguishes between complex and simple electronic hardware.

Special condition no. 10(d) requires data from assessments of all functional aspects of the control system to prevent errors that could exist in software programs that are not readily observable by inspection of the code. Also, ZeroAvia must use methods that will result in the expected quality that ensures the engine control system performs the intended functions throughout the declared operational envelope.

The environmental limits referred to in special condition no. 10(e) include temperature, vibration, high-intensity radiated fields (HIRF), and others addressed in RTCA DO–160G, ''Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments'' dated December 8, 2010, which includes ''DO–160G Change 1—Environmental Conditions and Test Procedures for Airborne Equipment'' dated December, 16, 2014, and ''DO–357—User Guide: Supplement to DO–160G'' dated December 16, 2014.[4] Special condition 10(e) requires ZeroAvia to demonstrate by system or component tests in special condition no. 27 any environmental limits that cannot be adequately substantiated by the endurance demonstration, validated analysis, or a combination thereof.

Special condition no. 10(f) requires ZeroAvia to evaluate various control system failures to ensure that such failures will not lead to unsafe engine conditions. The FAA issued Advisory Circular (AC) AC 33.28–3, ''Guidance Material for 14 CFR 33.28, Engine Control Systems,'' on May 23, 2014, for reciprocating and turbine engines.[5] Paragraph 6–2 of this AC provides guidance for defining an engine control system failure when showing compliance with the requirements of § 33.28. AC 33.28–3 also includes objectives for control system integrity requirements, criteria for a loss of thrust (or power) control (LOTC/LOPC) event, and an acceptable LOTC/LOPC rate. The electrical and electronic failures and failure rates did not account for electric engines when the FAA issued this AC, and therefore performance-based special conditions are established to allow fault accommodation criteria to be developed for electric engines.

The phrase ''in the full-up configuration'' used in special condition no. 10(f)(2) refers to a system without any fault conditions present. The electronic control system must, 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.

The term ''local'' in the context of ''local events'' used in special condition no. 10(f)(4) means failures or malfunctions leading to events in the intended aircraft installation such as fire, overheat, or failures leading to damage to engine control system components. These local events must not result in a hazardous engine effect due to engine control system failures or malfunctions.

Special condition no. 10(g) requires ZeroAvia to conduct a safety assessment of the control system to support the safety analysis in special condition no. 17. This control system safety assessment provides engine response to failures, and rates of these failures that can be used at the aircraft-level safety assessment.

Special condition no. 10(h) requires ZeroAvia to provide appropriate protection devices or systems to ensure that engine operating limits will not be exceeded in service.

Special condition no. 10(i) is necessary to ensure that the controllers are self-sufficient and isolated from other aircraft systems. The aircraft-supplied data supports the analysis at the aircraft level to protect the aircraft from common mode failures that could lead to major propulsion power loss. The exception ''other than power command signals from the aircraft,'' noted in special condition no. 10(i), is based on the FAA's determination that the engine controller has no reasonable means to determine the validity of any in-range signals from the electrical power system. In many cases, the engine control system can detect a faulty signal from the aircraft, but the engine control system typically accepts the power command signal as a valid value.

The term ''independent'' in the context of ''fully independent engine systems'' referenced in special condition no. 10(i) means the controllers should be self-sufficient and isolated from other aircraft systems or provide redundancy that enables the engine control system to accommodate aircraft data system failures. In the case of loss, interruption, or corruption of aircraft-supplied data, the engine must continue to function in a safe and acceptable manner without hazardous engine effects.

The term ''accommodated,'' in the context of ''detected and accommodated,'' referenced in special condition 10(i)(2) is to assure that, upon detecting a fault, the system continues to function safely.

Special condition no. 10(j) requires ZeroAvia to show that the loss of electric power from the aircraft will not cause the electric engine to malfunction in a manner hazardous to the aircraft. The total loss of electric power to the electric engine may result in an engine shutdown.

[3] *https://my.rtca.org/productdetails?id=a1B36000001IcjTEAS.*

[4] *https://my.rtca.org/NC__Product?id=a1B36000001IcnSEAS.*

[5] *https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_33_28-3.pdf.*

Instrument Connection: Special condition no. 11 requires ZeroAvia to comply with § 33.29(a), (e), and (g), which set certain requirements for the connection and installation of instruments to monitor engine performance. The remaining requirements in § 33.29 apply only to technologies used in reciprocating and turbine aircraft engines.

Instrument connections (wires, wire insulation, potting, grounding, connector designs, etc.) must not introduce unsafe features or characteristics to the aircraft. Special condition no. 11 requires the safety analysis to include potential hazardous effects from failures of instrument connections to function properly. The outcome of this analysis might identify the need for design enhancements or additional ICA to ensure safety.

Stress Analysis: Section 33.62 requires applicants to perform a stress analysis on each turbine engine. This regulation is explicitly applicable only to turbine engines and turbine engine components, and it is not appropriate for the ZeroAvia Model ZA601 electric engines. However, a stress analysis particular to these electric engines is necessary to account for stresses resulting from electric technology used in the engine.

Special condition no. 12 requires a mechanical, thermal, and electrical stress analysis to show that the engine has a sufficient design margin to prevent unacceptable operating characteristics. Also, the applicant must determine the maximum stresses in the engine by tests, validated analysis, or a combination thereof, and show that they do not exceed minimum material properties.

Critical and Life-Limited Parts: Special condition no. 13 requires ZeroAvia to show 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.

The term ''low-cycle fatigue,'' referenced in special condition no. 13(a)(2), is a decline in material strength from exposure to cyclic stress at levels beyond the stress threshold the material can sustain indefinitely. This threshold is known as the ''material endurance limit.'' Low-cycle fatigue typically causes a part to sustain plastic or permanent deformation during the cyclic loading and can lead to cracks, crack growth, and fracture. Engine parts that operate at high temperatures and high mechanical stresses simultaneously can experience low-cycle fatigue coupled with creep. Creep is the tendency of a metallic material to permanently move or deform when it is exposed to the extreme thermal conditions created by hot combustion gasses, and substantial physical loads such as high rotational speeds and maximum thrust. Conversely, high-cycle fatigue is caused by elastic deformation, small strains caused by alternating stress, and a much higher number of load cycles compared to the number of cycles that cause low-cycle fatigue.

The engineering plan referenced in special condition no. 13(b)(1) informs the manufacturing and service management processes of essential information that ensures the life limit of a part is valid. The engineering plan provides methods for verifying the characteristics and qualities assumed in the design data using methods that are suitable for the part criticality. The engineering plan informs the manufacturing process of the attributes that affect the life of the part. The engineering plan, manufacturing plan, and service management plan are related in that assumptions made in the engineering plan are linked to how a part is manufactured and how that part is maintained in service. For example, environmental effects on life limited electric engine parts, such as humidity, might not be consistent with the assumptions used to design the part. ZeroAvia must ensure that the engineering plan is complete, available, and acceptable to the Administrator.

The term ''manufacturing plan,'' referenced in special condition no. 13(b)(2), is the collection of data required to translate documented engineering design criteria into physical parts, and to verify that the parts comply with the properties established by the design data. Because engines are not intentionally tested to failure during a certification program, documents and processes used to execute production and quality systems required by § 21.137 guarantee inherent expectations for performance and durability. These systems limit the potential manufacturing outcomes to parts that are consistently produced within design constraints.

The manufacturing plan and service management plan ensure that essential information from the engineering plan, such as the design characteristics that safeguard the integrity of critical and life-limited parts, is consistently produced and preserved over the lifetime of those parts. The manufacturing plan includes special processes and production controls to prevent inclusion of manufacturing-induced anomalies, which can degrade the part's structural integrity. Examples of manufacturing-induced anomalies are material contamination, unacceptable grain growth, heat-affected areas, and residual stresses.

The service-management plan ensures the method and assumptions used in the engineering plan to determine the part's life remain valid by enabling corrections identified from in-service experience, such as service-induced anomalies and unforeseen environmental effects, to be incorporated into the design process. The service-management plan also becomes the ICA for maintenance, overhaul, and repairs of the part.

Lubrication System: Special condition no. 14 requires ZeroAvia to ensure that the lubrication system is designed to function properly between scheduled maintenance intervals and to prevent contamination of the engine bearings. This special condition also requires ZeroAvia to demonstrate the unique lubrication attributes and functional capability of the ZeroAvia Model ZA601electric engine design.

The corresponding part 33 regulations include provisions for lubrication systems used in reciprocating and turbine engines. The part 33 requirements account for safety issues associated with specific reciprocating and turbine engine system configurations. These regulations are not appropriate for the ZeroAvia Model ZA601 electric engines. For example, electric engines do not have a crankcase or lubrication oil sump. Electric engine bearings are sealed, so they do not require an oil circulation system. The lubrication system in these engines is also independent of the propeller pitch control system. Therefore, special condition no. 14 incorporates only certain requirements from the part 33 regulations.

Power Response: Special condition no. 15 requires the design and construction of the ZeroAvia Model ZA601 electric engines to enable an increase from the minimum—

(1) power setting to the highest rated power without detrimental engine effects, and

(2) within a time interval appropriate for the intended aircraft application.

The engine control system governs the increase or decrease in power in combustion engines to prevent too much (or too little) fuel from being mixed with air before combustion. Due to the lag in rotor response time, improper fuel/air mixtures can result in engine surges, stalls, and exceedances above rated limits and durations. Failure of the combustion engine to provide thrust, maintain rotor speeds below rotor burst thresholds, and keep temperatures below limits can have engine effects detrimental to the aircraft. Similar detrimental effects are possible in the ZeroAvia Model ZA601 electric engines, but the causes are different. Electric engines with reduced power response time can experience insufficient thrust to the aircraft, shaft over-torque, and over-stressed rotating components, propellers, and critical propeller parts. Therefore, this special condition is necessary.

Continued Rotation: Special condition no. 16 requires ZeroAvia to design the Model ZA601 electric engines such that, if the main rotating systems continue to rotate after the engine is shut down while in-flight, this continued rotation will not result in any hazardous engine effects.

The main rotating system of the ZeroAvia Model ZA601 engines consists of the rotors, shafts, magnets, bearings, and wire windings that convert electrical energy to shaft torque. For the initial aircraft application, this rotating system must continue to rotate after the power source to the engine is shut down. The safety concerns associated with this special condition are substantial asymmetric aerodynamic drag that can cause aircraft instability, loss of control, and reduced efficiency; and may result in a forced landing or inability to continue safe flight.

Safety Analysis: Special condition no. 17 requires ZeroAvia to comply with § 33.75(a)(1) and (a)(2), which require the applicant to conduct a safety analysis of the engine, and which would otherwise be applicable only to turbine aircraft engines. Additionally, this special condition requires ZeroAvia to assess its engine design to determine the likely consequences of failures that can reasonably be expected to occur. The failure of such elements, and associated prescribed integrity requirements, must be stated in the safety analysis.

A primary failure mode is the manner in which a part is most likely going to fail. Engine parts that have a primary failure mode, a predictable life to the failure, and a failure consequence that results in a hazardous effect, are life-limited or critical parts. Some life-limited or critical engine parts can fail suddenly in their primary failure mode, from prolonged exposure to normal engine environments such as temperature, vibration, and stress, if those engine parts are not removed from service before the damage mechanisms progress to a failure. Due to the consequence of failure, these parts are not allowed to be managed by on-condition or probabilistic means because the probability of failure cannot be sensibly estimated in numerical terms. Therefore, the parts are managed by compliance with integrity requirements, such as mandatory maintenance (life limits, inspections, inspection techniques), to ensure the qualities, features, and other attributes that prevent the part from failing in its primary failure mode are preserved throughout its service life. For example, if the number of engine cycles to failure are predictable and can be associated with specific design characteristics, such as material properties, then the applicant can manage the engine part with life limits.

Complete or total power loss is not assumed to be a minor engine event, as it is in the turbine engine regulation § 33.75, to account for experience data showing a potential for higher hazard levels from power loss events in single-engine general aviation aircraft. The criteria in these special conditions apply to an engine that continues to operate at partial power after a single electrical or electronic fault or failure. Total loss of power is classified at the aircraft level using special condition nos. 10(g) and 33(h).

Ingestion: Special condition no. 18 requires ZeroAvia to ensure that these engines will not experience unacceptable power loss or hazardous engine effects from ingestion. The associated regulations for turbine engines, §§ 33.76, 33.77, and 33.78, are based on potential performance impacts and damage from birds, ice, rain, and hail being ingested into a turbine engine that has an inlet duct, which directs air into the engine for combustion, cooling, and thrust. By contrast, the ZeroAvia electric engines are not configured with inlet ducts.

An ''unacceptable'' power loss, as used in special condition no. 18(b), is such that the power or thrust required for safe flight of the aircraft becomes unavailable to the pilot. The specific amount of power loss that is required for safe flight depends on the aircraft configuration, speed, altitude, attitude, atmospheric conditions, phase of flight, and other circumstances where the demand for thrust is critical to safe operation of the aircraft.

Liquid and Gas Systems: Special condition no. 19 requires ZeroAvia to ensure that systems used for lubrication or cooling of engine components are designed and constructed to function properly. Also, if a system is not self-contained, the interfaces to that system would be required to be defined in the engine installation manual. Systems for the lubrication or cooling of engine components can include heat exchangers, pumps, fluids, tubing, connectors, electronic devices, temperature sensors and pressure switches, fasteners and brackets, bypass valves, and metallic chip detectors. These systems allow the electric engine to perform at extreme speeds and temperatures for durations up to the maintenance intervals without exceeding temperature limits or predicted deterioration rates.

Vibration Demonstration: Special condition no. 20 requires ZeroAvia to ensure the engine—

(1) is designed and constructed to function throughout its normal operating range of rotor speeds and engine output power without inducing excessive stress caused by engine vibration, and

(2) design undergoes a vibration survey.

The vibration demonstration is a survey that characterizes the vibratory attributes of the engine. It verifies that the stresses from vibration do not impose excessive force or result in natural frequency responses on the aircraft structure. The vibration demonstration also ensures internal vibrations will not cause engine components to fail. Excessive vibration force occurs at magnitudes and forcing functions or frequencies, which may result in damage to the aircraft. Stress margins to failure add conservatism to the highest values predicted by analysis for additional protection from failure caused by influences beyond those quantified in the analysis. The result of the additional design margin is improved engine reliability that meets prescribed thresholds based on the failure classification. The amount of margin needed to achieve the prescribed reliability rates depends on an applicant's experience with a product. The FAA considers the reliability rates when deciding how much vibration is ''excessive.''

Overtorque: Special condition no. 21 requires ZeroAvia to demonstrate that the engine is capable of continued operation without the need for maintenance if it experiences a certain amount of overtorque.

ZeroAvia's electric engine converts electrical energy to shaft torque, which is used for propulsion. The electric motor, controller, and high-voltage systems control the engine torque. When the pilot commands power or thrust, the engine responds to the command and adjusts the shaft torque to meet the demand. During the transition from one power or thrust setting to another, a small delay, or latency, occurs in the engine response time. While the engine dwells in this time interval, it can continue to apply torque until the command to change the torque is applied by the engine control. The allowable amount of overtorque during operation depends on the engine's response to changes in the torque command throughout its operating range.

Calibration Assurance: Special condition no. 22 requires ZeroAvia to subject the engine to calibration tests to establish its power characteristics and the conditions both before and after the endurance and durability demonstrations specified in special condition nos. 23 and 26. The calibration test requirements specified in § 33.85 only apply to the endurance test specified in § 33.87, which is applicable only to turbine engines. The FAA determined that the methods used for accomplishing those tests for turbine engines are not the best approach for electric engines. The calibration tests in § 33.85 have provisions applicable to ratings that are not relevant to the ZeroAvia Model ZA601 engines. Special condition no. 22 allows ZeroAvia to demonstrate the endurance and durability of the electric engine either together or independently, whichever is most appropriate for the engine qualities being assessed. Consequently, the special condition applies the calibration requirement to both the endurance and durability tests.

Endurance Demonstration: Special condition no. 23 requires ZeroAvia to perform an endurance demonstration test that is acceptable to the Administrator. The Administrator will evaluate the extent to which the test exposes the engine to failures that could occur when the engine is operated at up to its rated values, and determine if the test is sufficient to show that the engine design will not exhibit unacceptable effects in service, such as significant performance deterioration, operability restrictions, and engine power loss or instability, when it is run repetitively at rated limits and durations in conditions that represent extreme operating environments.

Temperature Limit: Special condition no. 24 requires ZeroAvia to ensure the engine can endure operation at its temperature limits plus an acceptable margin. An ''acceptable margin,'' as used in the special condition, is the amount of temperature above that required to prevent the least capable engine allowed by the type design, as determined by § 33.8, from failing due to temperature-related causes when operating at the most extreme engine and environmental thermal conditions.

Operation Demonstration: Special condition no. 25 requires the engine to demonstrate safe operating characteristics throughout its declared flight envelope and operating range. Engine operating characteristics define the range of functional and performance values the ZeroAvia Model ZA601 electric engines can achieve without incurring hazardous effects. The characteristics are requisite capabilities of the type design that qualify the engine for installation into aircraft and that determine aircraft installation requirements. The primary engine operating characteristics are assessed by the tests and demonstrations required by these special conditions. Some of these characteristics are shaft output torque, rotor speed, power consumption, and engine thrust response. The engine performance data ZeroAvia will use to certify the engine must account for installation loads and effects. These are aircraft-level effects that could affect the engine characteristics that are measured when the engine is tested on a stand or in a test cell. These effects could result from elevated inlet cowl temperatures, aircraft maneuvers, flowstream distortion, and hard landings. For example, an engine that is run in a sea-level, static test facility could demonstrate more capability for some operating characteristics than it will have when operating on an aircraft in certain flight conditions. Discoveries like this during certification could affect engine ratings and operating limits. Therefore, the installed performance defines the engine performance capabilities.

Durability Demonstration: Special condition no. 26 requires ZeroAvia to subject the engine to a durability demonstration. The durability demonstration must show that the engine is designed and constructed to minimize the development of any unsafe condition between maintenance intervals or between engine replacement intervals if maintenance or overhaul is not defined. The durability demonstration also verifies that the ICA is adequate to ensure the engine, in its fully deteriorated state, continues to generate rated power or thrust, while retaining operating margins and sufficient efficiency, to support the aircraft safety objectives. The amount of deterioration an engine can experience is restricted by operating limitations and managed by the engine ICA. Section 33.90 specifies how maintenance intervals are established; it does not include provisions for an engine replacement. Electric engines and turbine engines deteriorate differently; therefore, ZeroAvia will use different test effects to develop maintenance, overhaul, or engine replacement information for their electric engine.

System and Component Tests: Special condition no. 27 requires ZeroAvia to show that the systems and components of the engine perform their intended functions in all declared engine environments and operating conditions.

Sections 33.87 and 33.91, which are specifically applicable to turbine engines, have conditional criteria to decide if additional tests will be required after the engine tests. The criteria are not suitable for electric engines. Part 33 associates the need for additional testing with the outcome of the § 33.87 endurance test because it is designed to address safety concerns in combustion engines. For example, § 33.91(b) requires the establishment of temperature limits for components that require temperature-controlling provisions, and § 33.91(a) requires additional testing of engine systems and components where the endurance test does not fully expose internal systems and components to thermal conditions that verify the desired operating limits. Exceeding temperature limits is a safety concern for electric engines. The FAA determined that the § 33.87 endurance test might not be the best way to achieve the highest thermal conditions for all the electronic components of electric engines because heat is generated differently in electronic systems than it is in turbine engines. Additional safety considerations also need to be addressed in the test. Therefore, special condition no. 27 is a performance-based requirement that allows ZeroAvia to determine when engine systems and component tests are necessary and to determine the appropriate limitations of those systems and components used in the ZeroAvia Model ZA601 electric engine.

Rotor Locking Demonstration: Special condition no. 28 requires the engine to demonstrate reliable rotor locking performance and that no hazardous effects will occur if the engine uses a rotor locking device to prevent shaft rotation.

Some engine designs enable the pilot to prevent a propeller shaft or main rotor shaft from turning while the engine is running, or the aircraft is in-flight. This capability is needed for some installations that require the pilot to confirm functionality of certain flight systems before takeoff. The ZeroAvia engine installations are not limited to aircraft that will not require rotor locking. Section 33.92 prescribes a test that may not include the appropriate criteria to demonstrate sufficient rotor locking capability for these engines.

Therefore, this special condition is necessary.

The special condition does not define ''reliable'' rotor locking but allows ZeroAvia to classify the hazard as major or minor and assign the appropriate quantitative criteria that meet the safety objectives required by special condition no. 17 and the applicable portions of § 33.75.

Teardown Inspection: Special condition no. 29 requires ZeroAvia to perform a teardown or non-teardown evaluation after the endurance, durability, and overtorque demonstrations, based on the criteria in special condition no. 29(a) or (b).

Special condition no. 29(b) includes restrictive criteria for ''non-teardown evaluations'' to account for electric engines, sub-assemblies, and components that cannot be disassembled without destroying them. Some electrical and electronic components like ZeroAvia's are constructed in an integrated fashion that precludes the possibility of tearing them down without destroying them. The special condition indicates that, if a teardown cannot be performed in a non-destructive manner, then the inspection or replacement intervals must be established based on the endurance and durability demonstrations. The procedure for establishing maintenance should be agreed upon between the applicant and the FAA prior to running the relevant tests. Data from the endurance and durability tests may provide information that can be used to determine maintenance intervals and life limits for parts. However, if life limits are required, the lifing procedure is established by special condition no. 13, Critical and Life-Limited Parts, which corresponds to § 33.70. Therefore, the procedure used to determine which parts are life-limited, and how the life limits are established, requires FAA approval, as it does for § 33.70. Sections 33.55 and 33.93 do not contain similar requirements because reciprocating and turbine engines can be completely disassembled for inspection.

Containment: Special condition no. 30 requires the engine to have containment features that protect against likely hazards from rotating components, unless ZeroAvia can show the margin to rotor burst does not justify the need for containment features. Rotating components in electric engines are typically disks, shafts, bearings, seals, orbiting magnetic components, and the assembled rotor core. However, if the margin to rotor burst does not unconditionally rule out the possibility of a rotor burst, then the special condition requires ZeroAvia to assume a rotor burst could occur and design the stator case to contain the failed rotors, and any components attached to the rotor that are released during the failure. In addition, ZeroAvia must also determine the effects of subsequent damage precipitated by a main rotor failure and characterize any fragments that are released forward or aft of the containment features. Further, decisions about whether the ZeroAvia engine requires containment features, and the effects of any subsequent damage following a rotor burst, should be based on test or validated analysis. The fragment energy levels, trajectories, and size are typically documented in the installation manual because the aircraft will need to account for the effects of a rotor failure in the aircraft design. The intent of this special condition is to prevent hazardous engine effects from structural failure of rotating components and parts that are built into the rotor assembly.

Engine and Propeller Systems Test: Special condition no. 31 requires ZeroAvia to conduct functional demonstrations, including feathering, negative torque, negative thrust, and reverse thrust operations, as applicable, based on the propeller's or fan's variable pitch functions that are planned for use on these electric engines, using a representative propeller. The requirements of § 33.95 prescribe tests based on the operating characteristics of turbine engines equipped with variable pitch propellers, which include thrust response times, engine stall, propeller shaft overload, loss of thrust control, and hardware fatigue. The electric engines ZeroAvia uses have different operating characteristics that substantially affect their susceptibility to these and other potential failures typical of turbine engines. Because ZeroAvia's electric engines may be installed with a variable pitch propeller, the special condition is necessary.

General Conduct of Tests: Special condition no. 32 requires ZeroAvia to—

(1) include scheduled maintenance in the engine ICA;

(2) include any maintenance, in addition to the scheduled maintenance, that was needed during the test to satisfy the applicable test requirements; and

(3) conduct any additional tests that the Administrator finds necessary, as warranted by the test results.

For example, certification endurance test shortfalls might be caused by omitting some prescribed engine test conditions, or from accelerated deterioration of individual parts arising from the need to force the engine to operating conditions that drive the engine above the engine cycle values of the type design. If an engine part fails during a certification test, the entire engine might be subjected to penalty runs, with a replacement or newer part design installed on the engine, to meet the test requirements. Also, the maintenance performed to replace the part, so that the engine could complete the test, would be included in the engine ICA. In another example, if the applicant replaces a part before completing an engine certification test because of a test facility failure and can substantiate the part to the Administrator through bench testing, they might not need to substantiate the part design using penalty runs with the entire engine.

The term ''excessive'' is used to describe the frequency of unplanned engine maintenance, and the frequency of unplanned test stoppages, to address engine issues that prevent the engine from completing the tests in special condition nos. 32(b)(1) and (2), respectively. Excessive frequency is an objective assessment from the FAA's analysis of the amount of unplanned maintenance needed for an engine to complete a certification test. The FAA's assessment may include the reasons for the unplanned maintenance, such as the effects test facility equipment may have on the engine, the inability to simulate a realistic engine operating environment, and the extent to which an engine requires modifications to complete a certification test. In some cases, the applicant may be able to show that unplanned maintenance has no effect on the certification test results, or they might be able to attribute the problem to the facility or test-enabling equipment that is not part of the type design. In these cases, the ICA will not be affected. However, if ZeroAvia cannot reconcile the amount of unplanned service, then the FAA may consider the unplanned maintenance required during the certification test to be ''excessive,'' prompting the need to add the unplanned maintenance to mandatory ICA to comply with the certification requirements.

Engine Electrical Systems: The current requirements in part 33 for electronic engine control systems were developed to maintain an equivalent level of safety demonstrated by engines that operate with hydromechanical engine control systems. At the time § 33.28 was codified, the only electrical systems used on turbine engines were low-voltage, electronic engine control systems (EEC) and high-energy spark-ignition systems. Electric aircraft engines use high-voltage, high-current electrical systems and components that are physically located in the motor and motor controller. Therefore, the existing part 33 control system requirements do not adequately address all the electrical systems used in electric aircraft engines. Special condition no. 33 is established using the existing engine control systems requirement as a basis. It applies applicable airworthiness criteria from § 33.28 and incorporates airworthiness criteria that recognize and focus on the electrical power system used in the engine.

Special condition no. 33(b) ensures that all aspects of an electrical system, including generation, distribution, and usage, do not experience any unacceptable operating characteristics.

Special condition no. 33(c) requires the electrical power distribution aspects of the electrical system to provide the safe transfer of electrical energy throughout the electric engine.

Special condition no. 33(d) requires the engine electrical system to be designed such that the loss, malfunction, or interruption of the electrical power source, or power conditions that exceed design limits, will not result in a hazardous engine effect.

Special condition no. 33(e) requires ZeroAvia to identify and declare, in the engine installation manual, the characteristics of any electrical power supplied from the aircraft to the engine, or electrical power supplied from the engine to the aircraft via energy regeneration, and any other characteristics necessary for safe operation of the engine.

Special condition no. 33(f) requires ZeroAvia to demonstrate that systems and components will operate properly up to environmental limits, using special conditions, when such limits cannot be adequately substantiated by the endurance demonstration, validated analysis, or a combination thereof. The environmental limits referred to in special condition include temperature, vibration, HIRF, and others addressed in RTCA DO–160G, ''Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments.''

Special condition 33(g) requires ZeroAvia to evaluate various electric engine system failures to ensure that these failures will not lead to unsafe engine conditions. The evaluation includes single-fault tolerance, ensures no single electrical or electronic fault or failure would result in hazardous engine effects, and ensures that any failure or malfunction leading to local events in the intended aircraft application do not result in certain hazardous engine effects. The special condition also implements integrity requirements, criteria for LOTC/LOPC events, and an acceptable LOTC/LOPC rate.

Special condition 33(h) requires ZeroAvia to conduct a safety assessment of the engine electrical system to support the safety analysis in special condition no. 17. This safety assessment provides engine response to failures, and rates of these failures, that can be used at the aircraft safety assessment level.

The special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

Discussion of Comments

The FAA issued Notice of Proposed Special Conditions No. 33–25–02–SC for the ZeroAvia ZA601 electric engine which was published in the **Federal Register** on January 8, 2026 (91 FR 633).

No comments were received, and the special conditions are adopted as proposed.

Applicability

As discussed above, these special conditions are applicable to the ZeroAvia ZA601 electric engines. Should ZeroAvia apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, these special conditions would apply to that model as well.

Under standard practice, the effective date of final special conditions would be 30 days after the date of publication in the **Federal Register**. However, as the certification date for the ZeroAvia ZA601 electric engine is imminent, the FAA finds that good cause exists to make these special conditions effective upon publication.

Conclusion

This action affects only ZeroAvia ZA601 electric engines. It is not a rule of general applicability.

List of Subjects in 14 CFR Part 33

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

Authority Citation

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(f), 40113, 44701, 44702, 44704.

The Special Conditions

■ Accordingly, the Federal Aviation Administration (FAA) issues the following special conditions as part of the type certification basis for ZeroAvia's Model ZA601 engine. The applicant must also comply with the certification procedures set forth in title 14, Code of Federal Regulations (14 CFR) part 21.

1. Applicability:

(a) Unless otherwise noted in these special conditions, the engine design must comply with the airworthiness standards for aircraft engines set forth in 14 CFR part 33, except for those airworthiness standards that are specifically and explicitly applicable only to reciprocating and turbine aircraft engines or as specified herein.

(b) The applicant must comply with this part using a means of compliance, which may include consensus standards, accepted by the Administrator.

(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.

2. Engine Ratings and Operating Limits: 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:

(a) Shaft power, torque, rotational speed, temperature, and time for:

(1) Rated takeoff power;

(2) Rated maximum continuous power; and

(3) Rated maximum temporary power and associated time limit.

(b) Duty cycle and the rating at that duty cycle. The duty cycle must be declared in the engine type certificate data sheet.

(c) Cooling fluid grade or specification.

(d) Power-supply requirements.

(e) Any other ratings or limitations that are necessary for the safe operation of the engine.

(f) In determining the engine performance and operating limitations, the overall limits of accuracy of the engine control system, of the engine electrical systems, and of the necessary instrumentation as defined in § 33.5(a)(6) must be taken into account.

3. Materials: The engine design must comply with § 33.15.

4. Fire Protection: The engine design must comply with § 33.17(b) through (g). In addition—

(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.

(b) Electrical wiring interconnection systems must be protected against arc faults that can lead to a fire that could result in 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 that can lead to a fire do not cause a hazardous engine effect.

5. Durability: 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. The engine design must also comply with § 33.19(b).

6. Engine Cooling: 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 in accordance with § 33.5.

7. Engine Mounting Attachments and Structure: The engine mounting attachments and related engine structures must comply with § 33.23.

8. Accessory Attachments: The engine must comply with § 33.25.

9. Overspeed:

(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) of these special conditions. 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.

(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.

(c) The engine must not exceed the rotor speed operational limitations that could affect rotor structural integrity.

10. Engine Control Systems:

(a) Applicability. 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.

(b) Engine control. The engine control system must ensure that 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.

(c) Design Assurance. The software and complex electronic hardware, including programmable logic devices, must be:

(1) Designed and developed using a structured and systematic approach that provides a level of assurance for the encoded logic commensurate with the hazard associated with the failure or malfunction of the systems in which the devices are located; and

(2) Substantiated by a verification methodology acceptable to the Administrator.

(d) Validation. 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.

(e) Environmental Limits. 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.

(f) Engine control system failures. The engine control system must:

(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 in accordance with § 33.5;

(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;

(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

(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.

(g) System safety assessment. 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 in accordance with § 33.5.

(h) Protection systems. 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.

(i) Aircraft supplied data. 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:

(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

(2) Be able to be detected and accommodated by the control system.

(j) Engine control system electrical power.

(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.

(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.

11. Instrument Connection: The applicant must comply with § 33.29(a), (e), and (g).

(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.

(b) The applicant must provide instrumentation enabling the flight crew to monitor the functioning of the engine cooling system unless evidence shows that:

(1) Other existing instrumentation provides adequate warning of failure or impending failure;

(2) Failure of the cooling system would not lead to hazardous engine effects before detection; or

(3) The probability of failure of the cooling system is extremely remote.

12. Stress Analysis:

(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.

(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.

13. Critical and Life-Limited Parts:

(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.

(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.

(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.

(b) In establishing the integrity of each critical part or life-limited part, the applicant must provide the Administrator the following three plans for approval:

(1) an engineering plan, as defined in § 33.70(a);

(2) a manufacturing plan, as defined in § 33.70(b); and

(3) a service-management plan, as defined in § 33.70(c).

14. Lubrication System:

(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.

(b) The lubrication system must be designed to prevent contamination of the engine bearings and lubrication system components.

(c) The applicant must demonstrate by test, validated analysis, or a combination thereof, the unique lubrication attributes and functional capability of (a) and (b).

15. Power Response:

(a) The design and construction of the engine, including its control system, must enable an increase:

(1) From the minimum power setting to the highest rated power without detrimental engine effects;

(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

(3) From the minimum torque to the highest rated torque without detrimental engine effects in the intended aircraft application.

(b) The results of (a)(1), (a)(2), and (a)(3) of this special condition must be documented in accordance with § 33.5.

16. Continued Rotation: 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.

17. Safety Analysis:

(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.

(b) The primary failure of certain single elements cannot be sensibly estimated in numerical terms. If the failure of such elements is likely to result in hazardous engine effects, then compliance may be shown by reliance on the prescribed integrity requirements of § 33.15 and special condition nos. 9 and 13 of these special conditions, as applicable. These instances must be stated in the safety analysis.

(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, and the ICA in § 33.4.

(d) Unless otherwise approved by the Administrator, the following definitions apply to the engine effects when showing compliance with this condition:

(1) A minor engine effect does not prohibit the engine from performing its intended functions in a manner consistent with § 33.28(b)(1)(i), (b)(1)(iii), and (b)(1)(iv), and the engine complies with the operability requirements of special condition no. 15, special condition no. 25 and special condition no. 31 of these special conditions, as appropriate.

(2) The engine effects in § 33.75(g)(2) are hazardous engine effects with the addition of:

(i) Electrocution of the crew, passengers, operators, maintainers, or others; and

(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.

(3) Any other engine effect is a major engine effect.

(e) The intended aircraft application must be taken into account when performing the safety analysis.

(f) The results of the safety analysis, and the assumptions about the aircraft application used in the safety analysis, must be documented in accordance with § 33.5(c).

18. Ingestion:

(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.

(b) Ingestion from other likely sources (birds, foreign objects—ice slabs) must not result in unacceptable power or thrust loss, or hazardous engine effects defined by special condition no. 17(d)(2) of these special conditions, or unacceptable power loss.

(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 in accordance with § 33.5.

19. Liquid and Gas Systems:

(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.

(b) If a system used for lubrication or cooling of engine components is not self-contained, the interfaces to that system must be defined and documented in accordance with § 33.5.

(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:

(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;

(2) Exhibit fracture or burst when subjected to the greater of maximum possible pressures with margin.

(d) Compliance with special condition no. 19(c) of these special conditions must take into account:

(1) The operating temperature of the part;

(2) Any other significant static loads in addition to pressure loads;

(3) Minimum properties representative of both the material and the processes used in the construction of the part; and

(4) Any adverse physical geometry conditions allowed by the type design, such as minimum material and minimum radii.

(e) Approved coolants and lubricants must be documented in accordance with § 33.5.

20. Vibration Demonstration:

(a) The engine must be designed and constructed to function throughout its operating range of rotational 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.

(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.

21. Overtorque: 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.

22. Calibration Assurance: 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 condition nos. 23 and 26 of these special conditions.

23. Endurance Demonstration: 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, energy regeneration, and dwellings at the power settings and energy regeneration for sufficient durations that produce the extreme physical conditions the engine experiences at rated performance levels, operational limits, and at any other conditions or power settings, including energy regeneration, that are required to verify the limit capabilities of the engine.

24. Temperature Limit: The engine design must demonstrate its capability to endure operation at its temperature limits plus an acceptable margin. The applicant must quantify and justify the margin to the Administrator. The demonstration must be repeated for all declared duty cycles and ratings, and operating environments, which would impact temperature limits.

25. Operation Demonstration: The engine design must demonstrate safe operating characteristics, including but not limited to power cycling, starting, acceleration, overspeeding, and power response in accordance with special condition no. 15 of these special conditions, throughout its declared flight envelope and operating range. The declared engine operational characteristics must account for installation loads and effects.

26. Durability Demonstration: 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, to establish when the initial maintenance is required.

27. System and Component Tests: The applicant must show that systems and components that cannot be adequately substantiated in accordance with the endurance demonstration or other demonstrations will perform their intended functions in all declared environmental and operating conditions.

28. Rotor Locking Demonstration: If shaft rotation is prevented by locking the rotor(s), the engine must demonstrate:

(a) Reliable rotor locking performance;

(b) Reliable rotor unlocking performance; and

(c) That no hazardous engine effects, as specified in special condition no. 17(d)(2) of these special conditions, will occur.

29. Teardown Inspection:

(a) 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.

(b) 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.

(c) 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:

(1) established based on the endurance and durability demonstrations; and

(2) documented in the ICA in accordance with § 33.4.

30. Containment: The engine must be designed and constructed to protect against likely hazards from rotating components as follows:

(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.

(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.

31. Engine and Propeller Systems Test:

(a) An engine that is intended to be equipped with a propeller must be fitted for the endurance, durability, vibration and operation demonstrations with a representative propeller.

(b) For variable pitch propellers, the applicant must conduct functional demonstrations including feathering, negative torque, negative thrust, and reverse thrust operations, as applicable, with a representative propeller.

(c) The demonstrations must be accomplished in accordance with (a) and (b) or otherwise performed in a manner acceptable to the Administrator.

32. General Conduct of Tests:

(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.

(b) The applicant must subject the engine or its parts to any additional tests that the Administrator finds necessary if:

(1) The frequency of engine service is excessive;

(2) The number of stops due to engine malfunction is excessive;

(3) Major engine repairs are needed; or

(4) Replacement of an engine part is found necessary during the tests, or due to the teardown inspection findings.

(c) Upon completion of all demonstrations and testing specified in these special conditions, the engine and its components must be:

(1) Within serviceable limits;

(2) Safe for continued operation; and

(3) Capable of operating at declared ratings while remaining within limits.

33. Engine Electrical Systems:

(a) Applicability. 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.

(b) Electrical systems. The electrical system must ensure the safe generation and transmission of power, and electrical load shedding if load shedding is required, and that the engine does not experience any unacceptable operating characteristics or exceed its operating limits. Electrical wiring interconnection systems must be protected against arc faults that could result in hazardous engine effects as defined in special condition no. 17(d)(2) of these special conditions.

(c) Electrical power distribution.

(1) The engine electrical power distribution system must be designed to provide the safe transfer of electrical energy throughout the electric engine. 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.

(2) The system must be designed and maintained to withstand normal and abnormal conditions during all ground and flight operations.

(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.

(d) Protection systems. 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.

(e) Electrical power characteristics. The applicant must document, and provide to the installer as part of the requirements in § 33.5, the characteristics of any electrical power supplied from:

(1) the aircraft to the engine electrical system, for starting and operating the engine, including transient and steady state voltage limits, and

(2) the engine to the aircraft via energy regeneration, and any other characteristics necessary for safe operation of the engine.

(f) Environmental limits. 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.

(g) Electrical system failures. The engine electrical system must:

(1) Have a maximum rate of loss of power control (LOPC) that is suitable for the intended aircraft application;

(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;

(3) Not have any single failure that results in hazardous engine effects; and

(4) Ensure any electrical system 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.

(h) System safety assessment. 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 documented in accordance with § 33.5.

Issued in in Fort Worth, Texas, on March 13, 2026.

Jorge R. Castillo,

Manager, Technical Policy Branch, Policy and Standards Division, Aircraft Certification Service.

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DEPARTMENT OF THE INTERIOR

National Park Service

36 CFR Part 7

[NPS–GLCA–NPS0041103; NPS–2024–0005; PPIMGLCAS0 PPMPSAS1Z.Y00000 266P103601]

RIN 1024–AE91

Glen Canyon National Recreation Area; Motor Vehicles; Withdrawal

AGENCY: National Park Service; Interior.

ACTION: Final rule; withdrawal.

SUMMARY: This action withdraws a final rule that published on January 13, 2025. The National Park Service has terminated the rulemaking process.

DATES: The January 13, 2025, final rule (90 FR 2621) is withdrawn as of March 18, 2026.

FOR FURTHER INFORMATION CONTACT: Jacob Ohlson, Superintendent, Glen Canyon National Recreation Area, P.O. Box 1507, Page, Arizona 86040, by phone at 928–608–6209, or by email at *GLCA_Superintendent@nps.gov.* Individuals in the United States who are deaf, deafblind, hard of hearing, or have a speech disability may dial 711 (TTY, TDD, or TeleBraille) to access telecommunications relay services. Individuals outside the United States should use the relay services offered within their country to make international calls to the point-of-contact in the United States.

SUPPLEMENTARY INFORMATION: On Friday, May 23, 2025, the President of the United States signed the following bill into law: H.J. Res. 60—Joint Resolution providing for congressional disapproval under chapter 8 of title 5, United States Code, of the rule submitted by the National Park Service relating to ''Glen Canyon National Recreation Area: Motor Vehicles.'' Public Law 119–13. The NPS published the final rule that was disapproved by H.R. Res. 60 on January 13, 2025 (90 FR 2621). The NPS delayed the effective date of the final rule on