Evaluation of a Standards-Based Assessment for Electric Propulsion in Aviation Programs

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Evaluation of a Standards-Based Assessment for Electric Propulsion in Aviation Programs: A Work in Progress

Abstract

The rapid integration of electric propulsion technologies in aviation underscores the critical need for future professionals to possess a clear understanding of industry standards that govern safety, design, and certification. This work-in-progress study follows on from work performed under NIST grant award number 70NANB22H200, under which the authors developed two instructional modules as part of phase one of the overall project. The modules are publicly available at https://polytechnic.purdue.edu/aircraft-electric-propulsion. The purpose of these modules is to increase student knowledge of the relationship between electric propulsion technologies and the applicable standards related to design requirements and airworthiness. This study presents phase two, which includes the revision of the assessment instruments based on further reliability and validation efforts designed to evaluate student knowledge of airworthiness requirements and minimum design standards for electric propulsion systems. The work will be completed in the fall of 2026.

The population includes both undergraduate and graduate students enrolled in aeronautical engineering technology and aviation management programs, reflecting the diverse professional pathways where knowledge of standards is essential.

Instrument validation was conducted through face validity and content validity procedures, engaging subject matter experts to ensure alignment with international standards such as those established by ASTM, SAE, and IEEE. Reliability was measured using a test–retest methodology, providing evidence of assessment stability over time. Item analysis was performed using point biserial (PBS) correlations to determine the discriminative power of individual items. Internal consistency was evaluated through Cronbach’s alpha, ensuring the instrument’s coherence in capturing the targeted knowledge domain.

By validating this assessment, the study contributes a robust measure to support the preparation of aviation professionals who must navigate evolving regulatory frameworks and technical requirements. Ensuring familiarity with industry standards is vital for cultivating a workforce equipped to advance aviation’s transition toward sustainable propulsion systems.

Introduction

The rapid growth of electric propulsion technologies in all aviation sectors is fundamentally reshaping the aerospace industry. Electric and hybrid-electric propulsion systems are being developed to improve energy efficiency, reduce emissions, and lower operational costs [1], [2]. This innovation allows for new aircraft configurations, such as electric vertical takeoff and landing (eVTOL), which accelerates the expansion of applications ranging from regional transportation to urban air mobility. As a result, future aviation professionals must be prepared to operate, maintain, and manage systems that differ significantly from traditional internal combustion and turbine-based propulsion architectures.

Airworthiness, certification, and minimum design standards governing these emerging technologies are becoming increasingly complex. Regulatory authorities are adapting existing frameworks while also developing new guidance material to address the unique safety, reliability, and performance challenges associated with high-voltage systems, energy storage, thermal management, and software-intensive control architectures. The absence of long-standing certification precedents further complicates compliance. Though the FAA and the International Civil Aviation Organization (ICAO) have recognized the environmental potential of electric propulsion, implementing performance-based airworthiness standards that accommodate innovative designs presents challenges [3]. Manufacturers and operators are then required to navigate evolving published regulations. The increased complexity underscores the need for targeted education and assessment of student knowledge related to regulatory standards, ensuring that graduates are equipped to meet certification expectations and to contribute effectively to the safe integration of electric propulsion aircraft into the global aviation system.

Problem and Purpose Statements

The problem that this study seeks to understand is the gap in the systematic assessment of student knowledge related to electric propulsion standards. The modules include videos, lesson plans, instructional material, and assessment questions, which are publicly available at https://polytechnic.purdue.edu/aircraft-electric-propulsion.

Airworthiness Requirements for Electric Propulsion: This module was based on ASTM F3239-22 (*Standard Specification for Aircraft Electric Propulsion Systems*) and emphasized airworthiness criteria across core system categories such as energy distribution, control and indication, hazard mitigation, and powerplant installation.

1. Introduction to Airworthiness Requirements for Electric Propulsion (with and without captions): 2:57 minutes with 10 assignment questions.
2. Terminology in ASTM F3239 (with and without captions): 3:56 minutes with 10 assignment questions.
3. Requirements in ASTM F3239 (with and without captions): 5:15 minutes with 10 assignment questions.

Minimum Design Requirements for Electric Propulsion: Built around ASTM F3338-21 (*Design of Electric Engines for General Aviation Aircraft*), this module focuses on engineering design considerations and certification pathways.

1. Introduction to Minimum Requirements for Electric Propulsion (with and without captions): 4:56 minutes with 10 assignment questions
2. Terminology in ASTM 3338 (with and without captions): 3:34 minutes and 10 assignment questions.
3. Requirements and Ratings in ASTM F3338-24 (with and without captions): 5:03 minutes and 10 assignment questions.
4. Endurance and Durability Testing in ASTM F3338 (with and without captions): 3:37 minutes and 10 assignment questions.

Additionally, the study highlights the importance of standards literacy across engineering and aviation pathways. The purpose of the study is the development and validation of an assessment instrument measuring the knowledge of airworthiness and minimum design standards for electric propulsion systems.

Research Questions

For this study, there are two research questions.

RQ1: To what extent does the instrument demonstrate acceptable validity and reliability?

RQ2: How effectively do individual items discriminate among levels of student knowledge?

Methodology

This work-in-progress study revises an assessment instrument based on further reliability and validity efforts using quantitative methods, including item-level analysis, point biserial (PBS) correlation coefficients, and Cronbach's Alpha. Validation for the instrument is accomplished through face and content validity. In addition to Cronbach's Alpha, reliability is assessed through the test/re-test process.

Participants and Population

The target population for the reliability and validity efforts of the assessment instrument will be students, faculty members, and industry professionals in aviation. The researchers anticipate enrolling approximately 50 participants for reliability and validity efforts. Solicitation will be accomplished through convenience sampling of personal contacts of the researchers, students, and faculty members from post-secondary aviation programs. The IRB application is in progress STUDY2025-00000020.

Instrument Development

To build knowledge of electric propulsion standards, two learning modules, consisting of multiple online videos, lesson plans, and assessments, were developed under NIST grant award number 70NANB22H200. A total of seven videos were created, and each video is accompanied by 10 multiple-choice questions (see Appendix A). The initial assessment questions were developed by the researchers. As part of the work completed under the NIST grant, a short pilot test was completed with 49 aviation maintenance students as participants in April of 2025. Minor refinements were made to the assessment questions to:

1. Improve the clarity of specific assessment items.
2. Increase alignment with the specific language used in ASTM standards and FAA rulemaking documents.
3. Improve the website's layout for better usability and navigation, ensuring that educators can quickly locate and integrate lesson materials into their course platforms.

Phase one of the instrument development and analysis was completed under the NIST grant. The following validity and reliability efforts will be completed as phase two of the project in the spring of 2026.

Validity Procedures

Face and content validity of the assessment instrument were established through a systematic expert review process to ensure alignment with the intended knowledge domain of airworthiness requirements and minimum design standards for electric propulsion systems. Face validity focused on whether the assessment items appeared, on their surface, to appropriately measure the targeted constructs. Two or three subject matter experts were solicited to review the draft instrument and supporting documentation describing the assessment's purpose and intended student population.

A second group of experts, approximately three to five, will be used to complete the content validity. The experts will evaluate each item using predefined criteria related to clarity, relevance, and appropriateness. Clarity is the precision of item wording, the absence of ambiguity, and the use of terminology suitable for undergraduate and graduate students. Relevance is the extent to which each item addresses essential concepts associated with electric propulsion certification and airworthiness. Appropriateness considers whether the technical depth and difficulty level of items were consistent with expected learning outcomes across aviation management and aeronautical engineering technology programs.

Reliability Analysis

Reliability of the assessment instrument was evaluated using test-retest reliability and internal consistency measures. Test-retest reliability was assessed by administering the instrument to the same participants on two separate occasions. The separation was approximately two weeks. This duration reduces recall effects and minimizes the likelihood of changes in student knowledge. The administrations are to be conducted using the same method and standard procedures to ensure consistency. Pearson’s correlation coefficient was used to measure stability over time.

Cronbach’s Alpha is used to measure internal consistency or the degree to which items measure a common underlying construct. An alpha value of 0.70 or higher will be considered acceptable, and scores higher than 0.80 will indicate strong internal consistency.

Item Analysis

Item-level analysis was conducted using point biserial (PBS) correlation coefficients to evaluate the discriminative power of individual assessment items. PBS coefficients of 0.20 or higher is to be considered to demonstrate acceptable discrimination. Low-performing items will be examined to identify potential issues, including unclear wording, misalignment with content standards, or inappropriate difficulty levels. Low-performing items will be revised, replaced, or removed to improve overall instrument quality.

Data Collection and Analysis Procedures

Human subjects research approval will be obtained to solicit participants and subject matter experts, as well as to administer the assessment. It is expected that this will be considered exempt.

Data analysis on items such as item-level analysis, PBS, and Cronbach's alpha will be collected and calculated using university testing services or through learning management systems.

Discussion

The anticipated outcomes of the revised assessment instrument center on producing a more psychometrically robust, instructionally aligned, and diagnostically useful measure of student knowledge related to airworthiness requirements and minimum design standards for electric propulsion systems. Through enhanced reliability (e.g., improved Cronbach's alpha and test–retest stability) and strengthened validity evidence, the revised instrument is expected to yield more consistent and interpretable measures of student learning across both undergraduate and graduate populations. In particular, refinements informed by point biserial (PBS) item analysis will improve the discriminative capacity of individual items, ensuring that the instrument more effectively differentiates between varying levels of student mastery. From a curriculum development perspective, the instrument will function as both an evaluative and formative tool. At the program level, aggregated data can inform the curriculum by ensuring that standards-related competencies are scaffolded appropriately and aligned with expected graduate outcomes.

Conclusion

Building on phase one work, including initial assessment instrument development and pilot study, this work-in-progress study is to further evaluate the assessment instrument using multiple reliability and validity measures. These measures will be used to provide preliminary evidence that the instrument is a sound measure of student knowledge related to airworthiness requirements and minimum design standards for electric propulsion systems. This work will provide initial validation, which should suggest the instrument is suitable for use in both undergraduate and graduate aviation programs. Further refinement and administration across more diverse populations will strengthen the instrument's psychometric properties. This strength will support its application in advancing educational preparation for the evolving electric aircraft workforce.

References

[1] J. Zong, B. Zhu, Z. Hou, X. Yang and J. Zhai, "Evaluation and Comparison of Hybrid Wing VTOL UAV with Four Different Electric Propulsion Systems," *Aerospace,* p. 256, 2021.

[2] Z. Kuang, Y. Wang, X. Duan, D. Wu and S. Cui, "Drive Control Technology of Dual Three Phase Permanent," *Drive Control Technology of Dual Three Phase Permanent,* p. 2762, 2024.

[3] M.-H. Blue-Laine, M. Bendarkar, J. Xie, S. Briceno and D. Mavris, "A Model-Based System Engineering Approach to Normal," in *AIAA Aviation 2019 Forum*, 2019.

Appendix A

Assessment: Introduction to Airworthiness Requirements

Q1. What is one major reason flying on commercial airlines continues to be safe?
A. Innovations in autonomous pilot systems
B. Commitment to standard construction and maintenance procedures
C. High competition in airline services
Answer: B. Commitment to standard construction and maintenance procedures

Q2. What does the ASTM F3239 standard specifically address?
A. Airworthiness requirements for electric and hybrid-electric propulsion systems
B. Certification of scheduled commercial aircraft
C. Safety inspections for general aviation
Answer: A. Airworthiness requirements for electric and hybrid-electric propulsion systems

Q3. Which organization certifies civilian aircraft in the United States?
A. SAE International
B. Federal Aviation Administration (FAA)
C. International Air Transport Association (IATA)
Answer: B. Federal Aviation Administration (FAA)

Q4. Which category of civilian aviation is specifically linked to FAA Title 14 CFR Part 23?
A. Charter service
B. General aviation
C. Commercial scheduled service
Answer: B. General aviation

Q5. How do industry standards relate to FAA oversight?
A. They support compatibility and standardization but do not replace FAA oversight
B. They serve as mandatory legal codes for FAA enforcement
C. They only apply to international aviation operations
Answer: A. They support compatibility and standardization but do not replace FAA oversight

Q6. What kind of documents does the FAA publish to guide airworthiness beyond regulations?
A. International codes of conduct
B. Technical patent filings
C. Advisory circulars, airworthiness directives, and service bulletins
Answer: C. Advisory circulars, airworthiness directives, and service bulletins

Q7. What role do consensus standards play in aviation certification?
A. They provide additional guidance to complement FAA regulations
B. They are used exclusively for maintenance manuals
C. They dictate pricing and manufacturing costs
Answer: A. They provide additional guidance to complement FAA regulations

Q8. Who governs the FAA?
A. The United Nations Aviation Division
B. U.S. Department of Transportation
C. U.S. Department of Homeland Security
Answer: B. U.S. Department of Transportation

Q9. What is one key benefit of using industry standards in aviation?

A. They speed up aircraft boarding procedures
B. They eliminate the need for FAA inspection
C. They help maintain high safety standards through uniform procedures
Answer: C. They help maintain high safety standards through uniform procedures

Q10. Why might students be advised to ask their instructor about state aviation laws?

A. Because aviation regulation may vary across U.S. states
B. Because local regulations override FAA laws
C. Because each state issues its own aircraft certification
Answer: A. Because aviation regulation may vary across U.S. states

Assessment: Terminology in ASTM F3239

Q1. What are the first three sections typically found in ASTM standards?

A. Scope, Referenced Documents, Terminology
B. Introduction, Components, Summary
C. Overview, Implementation, Definitions
Answer: A. Scope, Referenced Documents, Terminology

Q2. Which standard contains comprehensive definitions for airworthiness-related terms?

A. ASTM F3239
B. ASTM F3060
C. FAA Title 14 CFR Part 23
Answer: A. ASTM F3239

Q3. What is the main function of an electric engine within the propulsion system?

A. Distribute electrical power across subsystems
B. Provide thrust for propulsion
C. Manage energy storage parameters
Answer: B. Provide thrust for propulsion

Q4. Which of the following is NOT explicitly listed as a component of an electric propulsion system in ASTM F3239?

A. Controller
B. Sensors
C. Avionics system
Answer: C. Avionics system

Q5. Why is standardized terminology important in the aviation industry?

A. It allows greater flexibility in documentation
B. It facilitates communication with clarity and precision
C. It minimizes the need for regulatory oversight
Answer: B. It facilitates communication with clarity and precision

Q6. What component in an electric propulsion system is equivalent to a fuel tank in a gasoline-based system?

A. Electric Motor
B. Disconnect Switch
C. Energy Storage System (ESS)
Answer: C. Energy Storage System (ESS)

Q7. Which of the following best defines the Energy Distribution System (EDS) in electric propulsion?

A. It delivers energy from the source to the electric engine
B. It controls software-based diagnostics
C. It measures thermal output during engine operation
Answer: A. It delivers energy from the source to the electric engine

Q8. What issue is highlighted by the term "quantity" in the context of standardized definitions?

A. Measuring battery voltage accurately
B. Synchronizing controller signals with motor output
C. Inconsistent interpretation of what and when to measure
Answer: C. Inconsistent interpretation of what and when to measure

Q9. What is the practical reason battery manufacturers restrict full access to usable energy capacity?

A. To prolong battery life
B. To prevent overheating during emergency landing
C. To meet FAA battery certification criteria
Answer: A. To prolong battery life

Q10. How are "capacity" and "usable energy capacity" different in electric propulsion systems?

A. They are completely synonymous
B. Usable energy capacity is a subset limited by design
C. Capacity only applies to fuel-cell powered systems
Answer: B. Usable energy capacity is a subset limited by design

Assessment: Requirements in ASTM F3239

Q1. What is one reason why ASTM F3239 includes references to other standards in the powerplant installation section?

A. To limit the scope of installation requirements
B. To build on existing requirements without duplicating details
C. To avoid FAA regulatory conflicts
Answer: B. To build on existing requirements without duplicating details

Q2. In both gasoline and electric propulsion systems, what is a shared requirement for the oil system?

A. It must be integrated with the cooling system
B. It can be shared across engines
C. It must be independent and maintain a safe operating temperature
Answer: C. It must be independent and maintain a safe operating temperature

Q3. What condition must the energy distribution system be able to support to meet F3239 requirements?

A. Emergency landings with full payload
B. Maximum continuous power for at least 30 minutes
C. Full system recharge in under one hour
Answer: B. Maximum continuous power for at least 30 minutes

Q4. Why must multiple electric engines have independent energy distribution systems?
A. To maintain redundancy and safety during operation
B. To reduce aircraft manufacturing costs
C. To simplify FAA inspections
Answer: A. To maintain redundancy and safety during operation

Q5. According to the video, what determines where energy system independence begins and ends?
A. Guidance provided in FAA advisory circulars
B. Pilot discretion during certification
C. Manufacturer's design flexibility
Answer: C. Manufacturer's design flexibility

Q6. What types of systems are discussed in the hazard mitigation section of the standard?
A. Propeller pitch and torque systems
B. Electrical connectors and valves
C. Protection against fire, lightning, and ice
Answer: C. Protection against fire, lightning, and ice

Q7. Why is it important to define what the pilot can replace in energy storage systems?
A. It affects the resale value of the aircraft
B. It determines insurance eligibility
C. It ensures pilot actions don't compromise system safety
Answer: C. It ensures pilot actions don't compromise system safety

Q8. What does the video emphasize about the similarity of requirements between gasoline and electric systems?
A. The requirements are completely different due to energy type
B. Many core requirements remain the same despite the energy source
C. Electric systems require fewer safety checks
Answer: B. Many core requirements remain the same despite the energy source

Q9. Why does the video compare standards to "puzzle pieces"?
A. Each contributes to a complete system of aviation safety
B. They replace the need for regulations
C. They vary greatly between countries
Answer: A. Each contributes to a complete system of aviation safety

Q10. What is one key takeaway the video wants learners to leave with?
A. The FAA no longer oversees electric aircraft
B. Standard definitions are optional in aviation
C. A working knowledge of standards improves aviation safety awareness
Answer: C. A working knowledge of standards improves aviation safety awareness

Assessment: Introduction to Minimum Requirements for Electric Propulsion

Q1: Why does ASTM F3338-24 not cover all possible engine configurations?
A. Because it is meant to be used alongside other supporting documents
B. Because most configurations are not airworthy
C. Because the FAA doesn't permit electric hybrid designs
Answer: A. Because it is meant to be used alongside other supporting documents

Q2: What is the role of the FAA in electric engine design approval in the U.S.?
A. It handles only post-certification inspections
B. It serves as the civil aviation authority and issues design guidance
C. It certifies only imported electric aircraft
Answer: B. It serves as the civil aviation authority and issues design guidance

Q3: What advantage does electric propulsion offer, as described in the video?
A. Reduced noise and no exhaust emissions
B. Faster takeoff speeds
C. Increased turbulence resistance
Answer: A. Reduced noise and no exhaust emissions

Q4: Which of the following is not one of the potential uses for electric aircraft mentioned in the video?
A. Air ambulance
B. Cargo delivery
C. Military combat operations
Answer: C. Military combat operations

Q5: What is significant about Pipistrel's Vellis Electro?
A. It is a hybrid engine aircraft certified for IFR
B. It was the first FAA-certified electric drone
C. It is the first type-certificated electric aircraft for pilot training
Answer: C. It is the first type-certificated electric aircraft for pilot training

Q6: What did the FAA grant in March 2024 regarding electric aircraft?
A. An LSA airworthiness exemption for flight training
B. A full type certificate for air taxis
C. An overhaul inspection waiver for electric motors
Answer: A. An LSA airworthiness exemption for flight training

Q7: Why are FAA "special conditions" being created for some electric engines?
A. To replace existing standards entirely
B. Because no standard certification yet exists for all electric engines
C. To relax safety requirements temporarily
Answer: B. Because no standard certification yet exists for all electric engines

Q8: How did the FAA establish the "special conditions" for certifying electric engines?
A. Based on international UN aviation goals
B. By combining Part 33 standards with F338-18 technical criteria
C. By exempting electric aircraft from existing rules
Answer: B. By combining Part 33 standards with F338-18 technical criteria

Q9: What milestone did Joby Aviation achieve in 2022?
A. They received their FAA Part 135 air carrier certificate
B. They flew across the Atlantic using electric propulsion
C. They were acquired by the Air Force
Answer: A. They received their FAA Part 135 air carrier certificate

Q10: As of 2025, what is one ongoing challenge for electric engine certification in the U.S.?
A. Limited funding from private companies
B. Incompatibility with U.S. airspace systems
C. Absence of comprehensive certification requirements for all electric engines
Answer: C. Absence of comprehensive certification requirements for all electric engines

Assessment: Terminology in ASTM F3338

Q1: Why is a common understanding of terminology important in aviation, according to the video?

A. It fosters teamwork and avoids confusion
B. It simplifies engine manufacturing
C. It allows for faster aircraft certification
Answer: A. It fosters teamwork and avoids confusion

Q2: How does the video define the role of an electric engine in aircraft?

A. It controls electronic signals from the cockpit
B. It converts electric power into mechanical thrust for propulsion
C. It manages the flight computer interface
Answer: B. It converts electric power into mechanical thrust for propulsion

Q3: What is the main difference between an electric engine and a motor, as explained in the video?

A. A motor requires fuel; an engine doesn't
B. A motor produces rotational power; an engine provides aircraft propulsion
C. An engine is smaller than a motor
Answer: B. A motor produces rotational power; an engine provides aircraft propulsion

Q4: What does "rated maximum continuous power" refer to in ASTM F3338?

A. Power used only during descent
B. Maximum power for 5 minutes
C. Brake power available for unrestricted use
Answer: C. Brake power available for unrestricted use

Q5: How long can "rated takeoff power" be used, as defined in the video?

A. No more than five minutes
B. Indefinitely during ascent
C. Up to 10 minutes in emergencies
Answer: A. No more than five minutes

Q6: Which of the following is an example of non-periodic duty in aircraft systems?

A. Landing gear retraction
B. Constant-speed propeller adjusting pitch during flight
C. Ice sensor monitoring
Answer: B. Constant-speed propeller adjusting pitch during flight

Q7: What characterizes periodic duty in aviation systems?

A. Random load variations throughout flight
B. Load spikes during power loss
C. One or more constant loads for specific durations
Answer: C. One or more constant loads for specific durations

Q8: What's the function of deicing boots as discussed in the context of duty types?

A. Non-periodic load balancing
B. Example of periodic duty due to fixed operating cycle
C. Heat dissipation management
Answer: B. Example of periodic duty due to fixed operating cycle

Q9: Which term best describes how the load behaves across operating ranges in periodic duty?

A. Constant for defined durations

B. Unpredictable and fluctuating

C. Constant with varied time

Answer: A. Constant for defined durations

Q10: How does ASTM F3338 reference external standards?

A. Only when no internal definitions exist

B. It avoids external references altogether

C. It calls out other standards like SAE J245 when needed

Answer: C. It calls out other standards like SAE J245 when needed

Assessment: Requirements and Ratings in ASTM F3338

Q1: What kind of information must be included for safe engine operation?

A. Things like maximum torque, temperature, and vibration limits

B. Marketing data and manufacturer logos

C. A list of all suppliers used during design

Answer: A. Things like maximum torque, temperature, and vibration limits

Q2: What factors influence how long and how hard an electric engine can run safely?

A. Paint finish and wing length

B. Duty cycle involving power, speed, torque, and time

C. Whether the aircraft is single- or twin-propeller

Answer: B. Duty cycle involving power, speed, torque, and time

Q3: How does the video say power ratings can be visually represented?

A. Through barcodes scanned into software

B. Using time-sequenced graphs or pre-defined duty profiles

C. Through temperature gauges on control panels

Answer: B. Using time-sequenced graphs or pre-defined duty profiles

Q4: What real-world example does the video use when discussing "overspeed"?

A. The rotor must not break apart even if spinning faster than normal

B. When the engine stalls mid-air

C. Pilots manually throttle up during storms

Answer: A. The rotor must not break apart even if spinning faster than normal

Q5: What kind of electric engine parts need to be taken out after a certain number of hours or flights?

A. Any parts exposed to wind

B. All cockpit controls

C. Life-limited parts like bearings with low-cycle fatigue

Answer: C. Life-limited parts like bearings with low-cycle fatigue

Q6: Which part is mentioned as critical, but not necessarily life-limited, in electric engines?

A. The propeller

B. The landing gear

C. The wing flaps

Answer: A. The propeller

Q7: What does the safety analysis process aim to do in electric engine design?

A. Ensure proper color coding on wiring
B. Identify what could go wrong and reduce hazard risks
C. Determine battery recharge speed
Answer: B. Identify what could go wrong and reduce hazard risks

Q8: What kind of events can block cooling systems in electric aircraft?

A. Dust storms and overheating
B. Cabin pressurization errors
C. Bird strikes, hail, or ice
Answer: C. Bird strikes, hail, or ice

Q9: What must happen if there's structural damage to a cooling system?

A. A restart sequence must be triggered
B. A flight delay must be reported
C. It should not lead to any hazardous engine behavior
Answer: C. It should not lead to any hazardous engine behavior

Q10: What is the takeaway message about engine safety and design?

A. That these engines are safer because they're smaller
B. That safety must be ensured in real conditions like failure and ingestion
C. That engines are mostly hands-off for pilots now
Answer: B. That safety must be ensured in real conditions like failure and ingestion

Assessment: Endurance and Durability Testing in ASTM F3338-24

Q1: What is the primary goal of endurance and durability testing for electric engines?

A. To ensure no unsafe condition develops during the engine's life or between overhauls
B. To increase battery cycle efficiency
C. To validate exterior aerodynamic features
Answer: A. To ensure no unsafe condition develops during the engine's life or between overhauls

Q2: What does vibration testing aim to confirm?

A. That the propeller blade angles stay fixed
B. That any vibration encountered is within acceptable limits
C. That the aircraft structure does not flex
Answer: B. That any vibration encountered is within acceptable limits

Q3: What must be proven during the over torque test?

A. That the engine can keep running without maintenance at over torque levels
B. That torque sensors are replaced post-test
C. That the engine fuel system is optimized
Answer: A. That the engine can keep running without maintenance at over torque levels

Q4: What is a key requirement of the over temperature test?

A. Continuous operation for at least 6 hours
B. Rotor magnets must exceed their thermal rating
C. Operation until steady-state plus one hour, with magnets within limits
Answer: C. Operation until steady-state plus one hour, with magnets within limits

Q5: What is the main purpose of calibration tests?
A. To align the engine's GPS unit
B. To establish power characteristics across operational ranges
C. To ensure the weight-to-thrust ratio meets baseline specs
Answer: B. To establish power characteristics across operational ranges

Q6: What types of functions are included in operation testing?
A. Landing gear extension, retraction, and braking
B. Throttle smoothing and taxiing
C. Powering on, idling, accelerating, and overspeeding
Answer: C. Powering on, idling, accelerating, and overspeeding

Q7: What does the power response test assess?
A. Flight time per battery cycle
B. The engine's ability to increase from minimum to peak power without damage
C. Noise levels at different altitudes
Answer: B. The engine's ability to increase from minimum to peak power without damage

Q8: When are rotor locking tests performed?
A. Only on hybrid-electric engines
B. If the engine has a rotor-locking feature that must be tested under torque
C. At cruising speed with autopilot engaged
Answer: B. If the engine has a rotor-locking feature that must be tested under torque

Q9: What happens during the teardown inspection?
A. The engine is fully disassembled and inspected post-testing
B. The batteries are swapped and discarded
C. The cooling system is flushed and re-oiled
Answer: A. The engine is fully disassembled and inspected post-testing

Q10: What is the focus of containment testing?
A. Evaluating wiring insulation under pressure
B. Verifying propeller pitch memory
C. Assessing energy and path of any fragments from rotating component failures
Answer: C. Assessing energy and path of any fragments from rotating component failures