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ASSEMBLY — 42ND SESSION

TECHNICAL COMMISSION

Agenda Item 24: Aviation Safety and Air Navigation Priority Initiatives

**RESEARCH ON KEY SAFETY RISKS AND RELATED AIRWORTHINESS REQUIREMENTS
OF ELECTRIC PROPULSION AIRCRAFT**

(Submitted by China)

EXECUTIVE SUMMARY	
During the certification process of electric propulsion aircraft, some key safety risks were identified and recommended airworthiness requirements were developed. It is recommended that the International Civil Aviation Organization take note of the information contained in this paper.	
<i>Strategic Goals:</i>	This working paper relates to <i>Every Flight is Safe and Secure</i> .
<i>Financial implications:</i>	This working paper has no financial implications.
<i>References:</i>	

¹ English and Chinese versions provided by China.

1. INTRODUCTION

1.1 The International Civil Aviation Organization (ICAO) has proposed its strategic plan for 2026-2050, with one of its strategic objectives being a comprehensive legal framework to maintain responsive international air law addressing current and emerging challenges. In recent years, due to the advocacy of aviation emission reduction and the development of electric propulsion technology, there has been a global trend in the research and development of electric propulsion aircraft. The main differences between electric propulsion aircraft and traditional power aircraft are electric motors, batteries, and electric propulsion control systems.

1.2 Recognizing the rapid development of electric propulsion aircraft, the challenges faced by airworthiness certification, and the necessity of coordinating airworthiness standards among countries, China and Singapore jointly submitted a Working Paper concentrating on “Research and Development of Airworthiness Requirements for Electric Powered Aircraft” at the 41st Session of the ICAO Assembly. It is recommended that the airworthiness expert group to develop appropriate airworthiness standards or guidance materials for the airworthiness certification of electric propulsion aircraft.

1.3 The above Working Paper had been officially adopted by the 41st Session of the ICAO Assembly. The Airworthiness Panel under the ICAO’s Air Navigation Committee has been conducting standard research on electric and hybrid propulsion systems. The Airworthiness Panel Working Group 4 has developed a multi-year research plan, aiming to develop Recommended Practices and Guidance Material for Annex 8 — *Airworthiness of Aircraft*. Currently, it is in the research stage of evaluating existing regulations and guidance materials in various countries.

1.4 At present, there are no specific airworthiness requirements for electric propulsion aircraft in the regulations of various countries. In order to ensure the airworthiness of electric propulsion aircraft, many countries have proposed airworthiness requirements by formulating Special Conditions. During the certification process of electric propulsion aircraft types, CAAC identified some key safety risks.

2. DISCUSS

2.1 Electric propulsion aircraft have rapidly developed globally, and some electric propulsion aircraft types have obtained Type Certificates. Some countries have issued specific technical guidelines for the approval of electric propulsion aircraft with specific design configurations. For example, CAAC has developed special conditions SC-LSA-F2840-001 for the use of lithium-ion power batteries in RX1E series electric propulsion aircraft, SC-23-17 for the electric propulsion system of RX4E aircraft, and SC-21-002 for the EH216-S unmanned aerial vehicle system of Ehang. The European Union Aviation Safety Agency (EASA) has published Special Conditions such as SC-VTOL and SC-E19, providing airworthiness certification guidelines for vertical takeoff and landing aircraft and pure electric and hybrid power systems, respectively. The Federal Aviation Administration (FAA) has issued special conditions 2021-19926 to clarify the airworthiness standards for MagniX’s Magni350 and Magni650 electric motors. The specific content in the above special conditions reflects the authorities’ understanding in various countries regarding airworthiness standards for electric propulsion aircraft.

2.2 The key safety risks of electric propulsion aircraft. CAAC has identified the safety risks related to electric motors, electric propulsion control systems, and batteries that require special concerns through the issuance of special conditions and type approval for electric propulsion aircraft, such as the identification and compliance verification methods of adverse operation characteristics of electric motors after installation, the accumulation of electronic component reliability data related to electric motor safety

analysis, specific test methods for thermal runaway containment of power batteries, and the inability of high-voltage electrical component environmental identification test standards to be covered by DO-160 standards.

2.3 Airworthiness requirements for electric propulsion aircraft. Considering the aforementioned safety risks, CAAC recommends focusing on airworthiness requirements related to key safety risks involving electric motors, electric propulsion control systems, and batteries for electric propulsion aircraft, in accordance with the published CCAR-23 Chapter H and in combination with the approved types. Please refer to the attached document for details.

3. CONCLUSION

3.1 CAAC has actively explored and identified some key safety risks of electric propulsion aircraft, and proposed key points of airworthiness requirements for electric motors, electric propulsion control systems, and batteries for electric propulsion aircraft. It is recommended that ICAO and its Airworthiness Panel (AIRP) take note of the information contained in this paper.

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APPENDIX A

KEY POINTS OF AIRWORTHINESS REQUIREMENTS FOR ELECTRIC MOTORS, ELECTRIC PROPULSION CONTROL SYSTEMS, AND BATTERIES IN ELECTRIC PROPULSION AIRCRAFT

The key points of airworthiness requirements for electric motors and electric propulsion control systems are as follows:

1. Safety analysis
2. Verification and Environmental Limitations of Electric Propulsion Control System
3. Malfunctions in the electric propulsion control system
4. Safety assessment of electric propulsion control system
5. Protection of Electric Propulsion Control System
6. Power supply for electric propulsion control system
7. Instrument connection
8. Fireproof
9. Installation components and structures
10. Critical parts and life-limited parts
11. Power response
12. Continuous rotation
13. Foreign objects ingestion
14. Cooling requirements
15. Vibration
16. Calibration test
17. Endurance test
18. Tear down inspection
19. Temperature limit

20. Operation test
21. System and component test
22. Durability
23. General test requirements

For lithium-ion power batteries, it is necessary to consider the following key points of airworthiness requirements:

1. Construction and distribution of power battery system
2. Windmill operation conditions
3. Normal operation conditions
4. Impact on surrounding devices
5. Short circuit
6. Charge and discharge
7. Electricity display and usage requirements
8. Impact on personnel
9. Cable installation
10. Design and installation of power batteries and distribution systems
11. Reliability
12. Instructions for Continued Airworthiness

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