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ENHANCING SAFETY IN AIR TRANSPORT OF DANGEROUS GOODS THROUGH INNOVATIVE TECHNOLOGIES

(Presented by China)

EXECUTIVE SUMMARY

With the rapid expansion of e-commerce in global trade, the changes in consumer habits and business trends have led to a notable increase in the volume of commodities containing dangerous goods being transported by air. In addition to ensuring compliance with existing safety standards and requirements, the strategic application of technological solutions by various stakeholders in the aviation sector can provide supplementary safeguard against the risks posed by undeclared or misdeclared dangerous goods. China recognizes and supports the collaborative efforts by administrations and the industry in taking proactive steps to further enhance aviation safety and efficiency in the supply chain through innovative technologies. This paper presents a number of initiatives showcasing the innovative use of technology in China for enhancing the safe transport of dangerous goods by air. The sharing of experiences of the latest technological advancements may contribute to the formulation of future standards and recommended practices that address practical needs while ensuring a robust and resilient aviation system.

<i>Strategic Goals:</i>	This working paper relates <i>Every Flight is Safe and Secure</i> .
<i>Financial implications:</i>	The activities referred to in the attached draft Assembly working paper will be undertaken subject to the resources available in the 2026 – 2028 Regular Budget and/or from extra-budgetary contributions as guided by the ICAO Business Plan 2026-2028.
<i>References:</i>	Annex 18 — <i>The Safe Transport of Dangerous Goods by Air</i>

¹ English and Chinese versions provided by China.

1. INTRODUCTION

1.1 The transport of dangerous goods by air poses unique safety challenges. As global trade expands and the need for swift logistics in e-commerce grows, the likelihood of dangerous goods being present in air freight shipment also rises. Besides ensuring compliance with existing safety standards and requirements, a proactive approach should be taken to explore additional measures for further mitigating the potential safety risks associated with the increasingly complex variety of cargo shipments. The integration of innovative technologies, such as artificial intelligence (AI), automation and real-time sensor-based monitoring, offers promising advancements to enhance safety, compliance, as well as efficiency.

1.2 This paper, jointly prepared by the Civil Aviation Administration of China (CAAC), the China Academy of Civil Aviation Science and Technology (CAST) and the Civil Aviation Department of Hong Kong, China (HKCAD), presents a number of initiatives showcasing the innovative use of technologies for enhancing the safe transport of dangerous goods by air. It reflects the shared commitment of both regulatory and industry stakeholders in the continuous pursuit for a safe and efficient air transport system.

2. RAPID DETECTION SYSTEM FOR WEAK MAGNETIC SUBSTANCES IN LARGE-SCALE CARGO TERMINALS

2.1 In response to the rapid development of cross-border e-commerce, the transportation demand for e-commerce cargo containing suspected magnetic substances, such as headphones, microphones, Bluetooth speakers, and refrigerator magnets, has surged significantly. However, such cargo often faces challenges in obtaining individual magnetic inspection reports, presenting new safety risks for aviation magnetic substance control.

2.2 To address aviation transportation risks and enhance the operational assurance capabilities of cargo terminals, the CAST has formed a technical team in collaboration with Shanghai Pudong International Airport Cargo Terminal and ShanghaiTech University to jointly develop a rapid detection system for weak magnetic substances in large-scale cargo terminals. The system comprises hardware components, including a large-scale fixed door frame, movable crossbar, and high-precision array sensors, along with software algorithms for automatic calibration and intelligent screening. Capable of measuring magnetic fields with a strength of 0.0398 A/m or above within $\pm 5\%$ accuracy, this system enables rapid on-site screening of entire palletized cargo units, significantly reducing shippers' magnetic inspection costs while improving on-site detection efficiency—a technical solution that achieves cost reduction and efficiency enhancement.



Figure 1. On-site implementation of rapid detection system for weak magnetic substances in large-scale cargo terminals

3. DANGEROUS GOODS STORAGE FACILITY SAFETY MANAGEMENT SYSTEM

3.1 The Dangerous Goods Storage Facility Safety Management System primarily comprises three functional modules: the Dangerous Goods Storage Management Module, the Real-time Monitoring and Early Warning Module, and the Emergency Support Decision-making Module.

3.2 The Dangerous Goods Storage Management Module incorporates functions such as incompatible cargo alerts, overdue cargo alerts, and overstock alerts, along with data statistics and storage management capabilities. This effectively resolves issues inherent in traditional manual operations, including cumbersome data verification processes and inefficient manual inspections. The Real-time Monitoring and Early Warning Module integrates multiple sensing technologies to conduct continuous monitoring of personnel behavior, toxic/hazardous gases, smoke/fire, dangerous goods leakage, and environmental conditions (temperature/humidity, foreign object intrusion). Automatic alerts are generated for any anomalies, enabling comprehensive, round-the-clock supervision of air transport storage facilities for dangerous goods. The Emergency Support Decision-making Module leverages an emergency response resource database to intelligently provide management personnel with emergency response plans, rescue guidelines, nearby disposal resources, and relevant incident case studies. This facilitates rapid and informed decision-making by emergency responders, significantly enhancing response speed and emergency handling capabilities.



Figure 2. Emergency support decision-making module

4. EARLY IDENTIFICATION OF FIRE HAZARD BY INTELLIGENT CARGO THERMAL DETECTION SYSTEM

4.1 A new intelligent cargo thermal detection system has been developed in Hong Kong, China through collaboration between the aviation industry and a local innovator. By combining advanced thermal imaging technology, thermodynamics, fluid mechanics, data analytics, and artificial intelligence, the system aims to identify cargo with potential fire hazard, which may arise from spontaneous combustion of the items being shipped, and to promptly alert the cargo handling personnel for follow-up actions in case unusually high temperatures are detected. It utilizes thermal imaging cameras to detect and monitor the temperature of cargo packaging, with correction applied based on the heat transfer properties of different types of packaging materials as determined from extensive test data collected during the research and development stage. To further enhance its accuracy and effectiveness, the system also incorporates real-time environmental factors such as ambient temperature, weather conditions and lighting conditions, maintaining its detection capabilities under diverse circumstances.

4.2 The intelligent cargo thermal detection system is designed for seamless integration into the cargo inspection process with minimal disruption to operations, and has been put into trial use in one of the cargo terminals in Hong Kong, China since late 2023. In the first phase of the project, the system enabled the cargo terminal operator to scan accepted cargo prior to loading onto aircraft. Recently, in the second phase of the project which was launched in mid-2025, the system has been further extended to scan bulk cargo during cargo acceptance to provide another layer of protection. There are plans to implement the same level of scrutiny for prepacked cargo at its acceptance. By enabling early detection of any abnormal temperatures in cargo, the system significantly reduces subsequent potential risks and losses faced by aircraft operators, cargo handlers and airports. It also provides additional protection to the terminal facility and its personnel, customers and air cargoes.

5. ENHANCED SCREENING OF LITHIUM BATTERY ASSISTED BY ARTIFICIAL INTELLIGENCE

5.1 Consequent to the growth of e-commerce shipments, there is a notable increase of dangerous goods such as modern devices powered by lithium batteries being transported by air and the amount of non-homogeneous shipments. As a result, it has become more challenging to identify hidden dangerous goods, such as lithium battery, from the complex array of e-commerce commodities on X-ray images. After analysing the trend and assessing the common lithium battery-related risks in the air cargo supply chain, one of the leading aircraft operators in Hong Kong, China has taken the initiative to coordinate with other industry partners to implement an enhanced lithium battery screening programme in 2024 at its base cargo terminal.

5.2 The programme aims to strategically scrutinize the cargo offered for carriage and identify high energy lithium battery for additional checking. The screening involves the use of AI-powered image analytics integrated into the existing X-ray screening equipment to assist screeners on the detection and identification of suspected lithium batteries in shipments, thereby reducing the potential risk of fire hazard associated with these relatively volatile items. With the algorithms adjusted for specific X-ray equipment models and operating systems, the lithium battery detection system aided by AI technology can automatically frame any suspected lithium battery in the X-ray image. This alert helps direct the attention of screeners to areas that might require further inspection without overloading them with excessive information superimposed onto the X-ray image. The installation of the AI technology into the X-ray equipment requires minimal effort and has also made it a cost-effective alternative solution which is preferred over the complete replacement of screening machines that offer similar detection capabilities.

6. CONCLUSION

6.1 Innovative technologies provide numerous opportunities to enhance the level of safety, efficiency, and regulatory compliance of air transport for dangerous goods. By leveraging these technological advancements, industry stakeholders can reduce safety risks while improving operational efficiency. As technology advances, the continued strategic adoption of new technological solutions coupled with the evolution of aviation safety standards will be crucial for fostering a safer global logistics network.

6.2 Close collaboration and information exchange between regulatory bodies and the industry can facilitate the integration of expertise from both sides. It is important to stay informed and supportive of the latest technological advancements, as these developments may contribute to the formulation of future standards and recommended practices that address practical needs while ensuring a robust and resilient aviation system.