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Agenda Item 31: Aviation Safety and Air Navigation Standardization

FEDERAL AVIATION ADMINISTRATION (FAA) CIVIL AEROSPACE MEDICAL INSTITUTE RESEARCH

(Presented by the United States)

EXECUTIVE SUMMARY

This paper summarizes the FAA Civil Aerospace Medical Institute (CAMI) major research initiatives. CAMI's Aerospace Human Factors and Aerospace Medical research programs study factors influencing human performance in the aerospace environment.

Interested States are invited to note the FAA CAMI research programs, and access CAMI research products online at https://www.faa.gov/data_research/research/med_humanfacs/.

Strategic Objectives:	This working paper relates to the Safety Strategic Objective.
Financial implications:	This information paper has no significant financial implications.
References:	None

1. INTRODUCTION

1.1 CAMI is the medical certification, research, education, and occupational health wing of the FAA's Office of Aerospace Medicine. The principal focus of CAMI is the human element in flight ─ pilots, flight attendants, passengers, air traffic controllers ─ and the entire human support system that encompasses civil aviation.

1.2 The CAMI Aerospace Human Factors and Medical research programs study the factors influencing human performance in the aerospace environment, find ways to understand them, and communicate that understanding to the aerospace community. CAMI researchers collaborate with other experts from the FAA and external institutions. The work of CAMI research programs is published online and has supported ICAO Panels and working groups.

2. DISCUSSION

2.1 CAMI's Aerospace Human Factors organization conducts field and laboratory research supporting the performance of front-line aviation personnel, including pilots, air traffic controllers, mechanics, dispatchers, avionics (technical operations) technicians, flight attendants, and ramp workers, with the goal of improving operational efficiency and safety. Aerospace Human Factors research program domains are:

2.1.1 *Information processing and displays.* Integrating new and advanced information processing technologies, displays, systems, and operational concepts into the aviation environment has the potential to dramatically improve safety, access, efficiency, and throughput. This integration may also reduce infrastructure and life cycle costs. Empirical research answers critical questions about these factors and informs the development of new policy, safety standards, and approval criteria. Research goals include to:

a) inform operational safety, visual contrast, and resolution advisory alerting requirements for unmanned aircraft systems;

b) identify human factors considerations and performance impacts of advanced displays and applications (e.g. electronic flight bags, electronic data-driven charts, monocular and binocular Head Word Displays (HWDs), augmented reality for training and maintenance operations);

c) assess decision making and procedures for loss of control and other unexpected events;

d) evaluate pilot performance and operational considerations associated with using sensor-based technologies and advanced vision systems on various display types during low visibility approach and landing operations;

e) investigate the impact of reduced approach lighting on pilot performance in low visibility conditions;

f) identify the minimum visual features and visual aids required for low visibility take-off with and without advanced vision systems; and

g) characterize crew coordination impacts of dual Head-Up Displays (HUDs), dual HWDs, and mixed HUD/HWD during low visibility operations.

2.1.2 *Biophysiological delimiters.* Human operators in the aerospace system have biophysical *capabilities* and limitations that affect task performance. Research identifies minimum human performance standards and informs equipment design, including inherent capabilities and performance filters, psycho-physiological minima, and viable mitigations or accommodations.

2.1.3 *System design and automation.* Examining and considering the human performance impacts of system design and automation is critical for optimizing aerospace system operations while maintaining our standards for aviation safety. Optimizing the relationship between humans and technology requires focus on a complex set of factors, including:

a) technology and task automation;

b) system design and reliability;

c) procedures and processes; and

d) perceptions of new automation.

2.1.4 *Aviation workforce optimization.* A variety of aviation occupations exist to keep the aerospace system safe and efficient. Optimizing the aviation workforce is critical to the sustainability of a safe aerospace system over time and through workforce changes. Research goals include to:

a) assess technical training methods and technologies used for training Air Transportation System Specialists (in ICAO terminology, ATSEP), Air Traffic Controllers, maintenance, and pilots;

b) determine the personal and organizational factors that influence job success;

c) identify the job tasks and competencies of aviation occupations;

d) describe elements of job analysis and how job analysis relates to workload, error risk, staffing, automation, design of workstations, and procedural fitness; and

e) monitor changes in the aviation landscape that might affect selection, training, and performance.

2.1.5 *Organizational and program assessment.* Assessing the success of inter- and intra-organizational initiatives allows researchers to identify the factors that influence goal achievement, determine the effectiveness of the initiatives, and recommend changes to improve organizational effectiveness. Research efforts include:

a) assessment of agency external stakeholder and customer feedback;

b) assessment of internal stakeholder feedback;

c) performance of programmatic, verification and validation of internally derived research solutions as well as tools acquired by the FAA for use in operations; and

d) evaluation of safety culture, risk perception, and adherence within high reliability organizations.

2.2 CAMI's Aerospace Medical Research organization executes complementary applied research in the biomedical, biodynamics and survivability/cabin safety sciences. Its research focuses on safety sensitive personnel and airline passenger health, safety, and performance in current and forecasted future civilian aerospace operations. Additionally, this organization supports ongoing operational safety functions through its radiobiology and fatal accident medical case review/toxicological analysis programs. CAMI's Aerospace Medicine research program is developing the following operational capabilities, in six focus areas:

2.2.1 Pilot medical certification:

a) *Medical recertification of pilots with neurological and/or psychiatric conditions:* The ability to rapidly measure the adequacy of perceptual, cognitive, and information processing abilities associated with flying for use in the medical recertification evaluation of pilots with known or suspected neurological and/or psychiatric conditions;

b) *Performance-based medical recertification of airmen with chronic obstructive pulmonary disease:* The ability to forecast if an individual will be able to maintain adequate blood oxygen saturation at altitude without supplemental oxygen for use in the medical certification of pilots with chronic obstructive pulmonary disease;

c) *Medical recertification of pilots with prior COVID-19 infection:* The ability to screen for disease sequelae in pilots with a prior COVID-19 infection that increase the risk for degraded aviation performance or in-flight incapacitation;

d) *Alternative medical recertification pathways for pilots:* The ability to innovate and adapt approaches used in other risk management industries, as well as leverage biomedical monitoring devices, as potential risk mitigations in medical recertification;

e) *Pilot fitness for duty in the environment of federally legalized cannabis use:* The ability to recommend an empirically-based minimum period before considering a pilot fit for duty after recreational cannabis use, assuming federal legalization of cannabis sometime in the future;

f) *Pilot monitoring technology and aircraft automation mitigations for pilot aeromedical risk:* The ability to provide special issuances to pilot with disqualifying medical conditions based on the use of pilot monitoring technology to identify unsafe pilot states and triggering compensatory automation; and

g) *Remote aeromedical certification exam:* The ability to remotely accomplish key elements of the FAA Aviation Medical Examiner encounter using existing telemedicine technologies and validated procedures.

2.2.2 Safety management system:

a) *Aeromedical certification safety risk management in an FAA safety management system:* The ability to define aeromedical hazards and characterize risk, as informed by all relevant data sources, during pilot medical certification in a manner that aligns with the FAA's approach to safety risk management;

b) *Aeromedical certification safety assurance in an FAA safety management system:* The ability to evaluate continuously the effectiveness of pilot medical certification risk management decision-making and guiding policy and standards as well as identify new aeromedical hazards; and

c) *Aerospace medicine safety management system data environment:* The ability for FAA Office of Aerospace Medicine users to perform integrated queries across

multiple databases, search an extensive warehouse of aeromedical safety data, and display pertinent elements in an array of useful formats to support an aerospace medicine safety management system.

2.2.3 Functional genomics in aviation mishap forensic analyses:

a) *Forensic measurement of pilot fatigue state:* The ability to objectively measure pilot fatigue state in forensic samples obtained during accident investigations and to estimate pilot performance impacts; and

b) *Enhanced forensic assessment of pilot substance use:* The ability to detect performance impairment resulting from drug use by means of expression-based biological markers.

2.2.4 Transport category aircraft cabin air quality:

a) *Cabin health safety during an epi/pandemic:* The ability to minimize the risk of transmission of respiratory diseases of potential public health significance within transport aircraft cabins; and

b) *Assess and manage the risk of cabin air quality events in transport category aircraft:* The ability to identify and measure constituent levels resulting from bleed air in commercial aircraft cabins in operation in the United States, and to assess the potential health effects of such constituents on passengers and cabin and flight deck crew.

2.2.5 Occupant safety during adverse events:

a) *Influence passenger behaviours:* The ability to influence passenger behaviours through the evaluation, selection, and improvement of both existing and new methods of communicating safety information to the passenger before boarding, and during all phases of flight, to increase safety during adverse events;

b) *Certify new and novel cabin interior components and configurations:* The ability to ensure proposed new and novel cabin interior components and configurations provide the same level of safety to all occupants as provided by conventional seats; and

c) *Improve occupant crash protection in legacy aircraft/rotorcraft:* The ability to improve the level of occupant crash protection provided by existing and newly produced aircraft/rotorcraft built to meet only static load qualification standards through complementary improvements to the airframe, fuel systems, seats and restraints.

2.2.6 Streamline airworthiness certification:

a) Efficiently assess the effect of cabin interior configuration and safety equipment changes on emergency egress/ditching/water survival: The ability to efficiently certify unconventional cabin interior and structural configurations and the addition or change of safety equipment to the aircraft cabin being proposed by industry;

b) Performance-based certification strategies for cabin interior components and configurations: The ability to certify cabin interior components and configurations using performance-based standards that take into account the whole aircraft response to impact and provide greater design flexibility; and

c) Performance-based certification strategies for oxygen systems: The ability to provide an equivalent level of safety using performance-based standards rather than prescriptive-based standards when certifying new oxygen mask designs, oxygen delivery systems (e.g., continuous, pulse, on demand, etc.), and oxygen regulators.

3. CONCLUSION

3.1 The Assembly and interested States are invited to:

a) note the FAA CAMI Aerospace Human Factors and Aerospace Medical research programs that study factors influencing human performance in the aerospace environment; and

b) consider accessing CAMI research products online at https://www.faa.gov/data_research/research/med_humanfacs/.

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