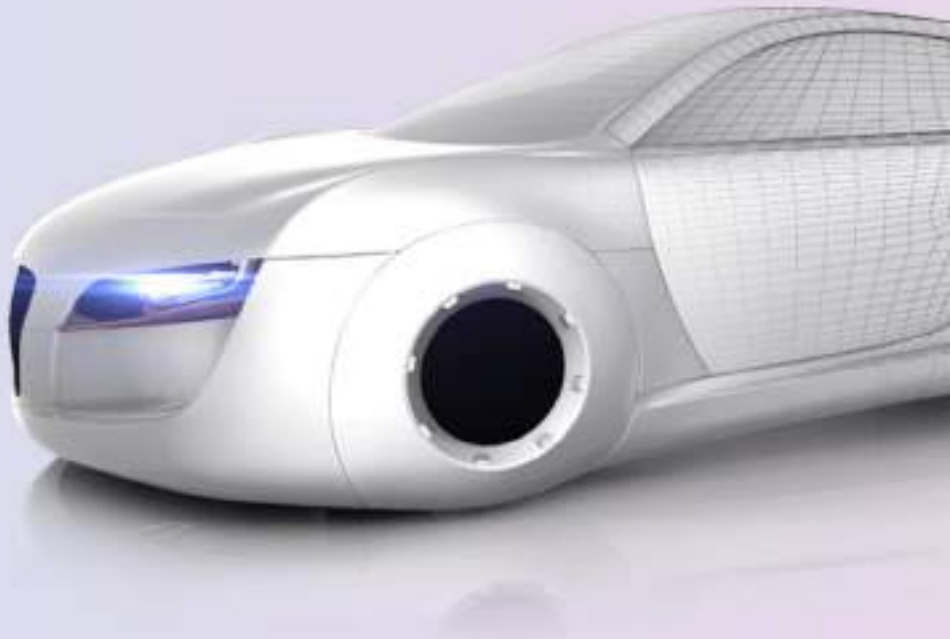
DUBAI WORLD CONGRESS
FOR SELF-DRIVING TRANSPORT
OCT | 2019

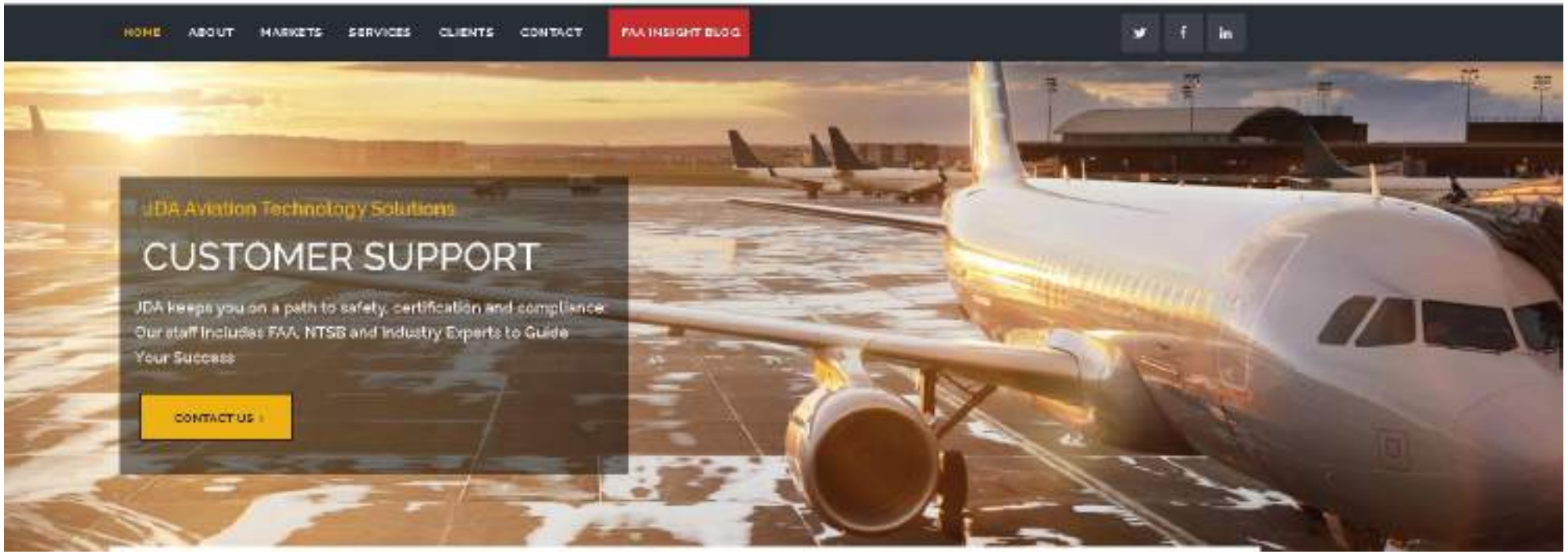
From Concept to Reality



Mike Rioux and Mike Borfitz
JDA Aviation Technology Solutions

www.jdasolutions.aero

JDA



- AIRPORT SERVICES
- AVIATION SECURITY
- CERTIFICATED AIR CARRIERS
- CIVIL AVIATION AUTHORITIES
- DOCUMENT TRANSLATION
- EXPERTS FOR ATTORNEYS
- INTERNATIONAL AIR CARRIERS
- NEW AND CERTIFICATED REPAIR STATIONS, US AND INTERNATIONAL
- NEW APPLICANT AIR CARRIERS
- OBSTRUCTION EVALUATION AND AIRSPACE ANALYSIS
- SAFETY
- TC/STC/PMA/TSOA
- UNMANNED AIRCRAFT SYSTEM AND URBAN AIR MOBILITY
- TRAINING

Urban Air Mobility – *From Concept to Reality*

The Jetsons – 1962

People live in housing in the sky, work a three-day workweek, drive aero-cars

NASA – 2019

Safe and efficient air transportation system - small package delivery drones to passenger-carrying air taxis operating above populated areas.

Focus on passenger carrying air taxis

London

Los Angeles

Dubai

Melbourne

Sao Paulo

Beijing

Chicago Metro Planning Council - congestion costs $7.3B USD annually; $824 to $3,014 per automobile.
Loss in regional employment = 87,000 jobs.

Urban Air Mobility

- On-demand/scheduled air transport within urban areas and suburban destinations
- Hybrid or electric-powered, vertical T/O and landing (eVTOL) aircraft.
- Pilot → Pilot/Safety Observer → Autonomous
- Role in rural connectivity.
- Uncongested, low-altitude airspace
  - Improved transportation efficiency
- Shared transportation system
  - Seamlessly integrates surface and air transportation.

Urban Air Mobility – *From Concept to Reality*

- 4 years ago ~ 8 UAM designs and manufacturers
- Today ~ 170 UAM designs and manufacturers








Urban Air Mobility – Business Model

- Global market for UAM released by Nexa Advisors, aerospace advisory firm.
  - 74 cities capable of UAM: 2020-40 direct value of $318B: $244B in operator revenue, $32B infrastructure and ATM and $41B in eVTOL sales.
- On-demand flights similar to ridesharing companies.
- Part 135 charter authority → demand warrants more fluid flight schedule - commuter.
- eVTOL operate in dense urban cores with high degree of maneuverability.
- Low noise electric propulsion promotes societal acceptance.
- Value proposition: commuters waste millions of hours stuck in road congestion.
- Commuters pay premium for early UAM adoption - provide reduction in road congestion and incentive for policymakers to promote UAM.
- Reduced seat-mile cost: Goal - ride-share UAM costs same as ride-share surface costs
  - Seamlessly integrate transportation modes.

UAM Operations – Evolving Program

- Initial UAM operations:
  - Low-tempo, low-density along small # fixed routes between few takeoff and landing areas
- Early expanded UAM operations:
  - Higher-tempo, higher-density flights in small network of Vertiports feeding common hub location and managed by UAM operator and third-party services
- Mature UAM operations:
  - High-tempo, high-density flights in network with multiple hub locations, with orders-of-magnitude more vehicles and operations then currently supported in airspace system.

- Safety
- Business Model
- Air Traffic Control/Airspace Integration
- Vertiports/Heliports
- Noise/Environment
- Autonomy
- Security
- Certifications (Aircraft and Operator)
- Battery Technology
- Intermodal Connectivity

Safety

UTM/ATM

Heliport/Vertiport

Data Communications

Security

Business Model

Type Certification

Operator Certification

Noise Environmental

Intermodal Connectivity

UAM Type Certification and Production Certification

- UAE member of ICAO since 1972
- UAE General Civil Aviation Authority (GCAA); Established 1996
  - " . . . to regulate Civil Aviation and provide designated aviation services with emphasis on safety and security to regulate Civil Aviation and provide designated aviation services with emphasis on safety and security . . ."
- Developed UAS Regulatory Framework
  - " . . . for UAS/drone operations in UAE."
- CAR-UAS "Unmanned Aircraft Systems (UAS) and Operations"
  - Effective March 2018, but does **not** apply to " . . . *UA intended for carriage of passengers."*

UAM Type Certification and Production Certification
GCAA and EASA

- GCAA 2008 agreement with EASA :
  - "The acceptance by the Importing Party of the airworthiness certification of civil aeronautical products . . ."
- EASA Special Condition SC-VTOL-01
  - " . . .for a person carrying VTOL aircraft in the small category, with lift/thrust units used to generate powered lift and control."
  - Passenger carrying UAM must be shown to have probability of 10 e-7 or less for catastrophic failures

EASA European Union Aviation Safety Agency	SPECIAL CONDITION Vertical Take-Off and Landing (VTOL) Aircraft	Doc. No: SC-VTOL-01 Issue: 1 Date: 2 July 2019

Special Condition for small-category VTOL aircraft

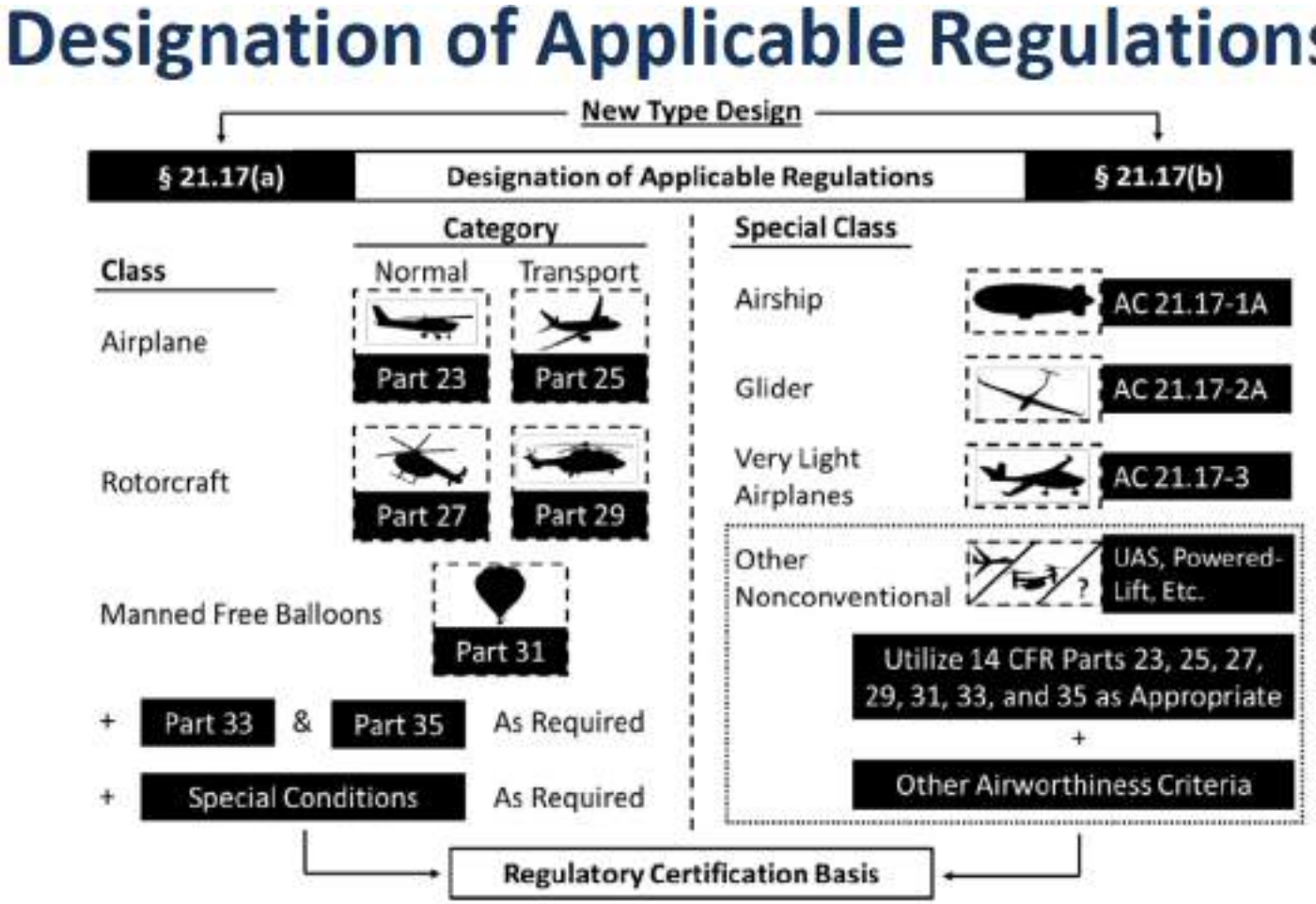
Statement of Issue

The Agency has received a number of requests for the type certification of vertical take-off and landing (VTOL) aircraft, which differ from conventional rotorcraft or fixed-wing aircraft. In the absence of certification specifications for the type certification of this type of product, a complete set of dedicated technical specifications in the form of a special condition for VTOL aircraft has been developed. This special condition addresses the unique characteristics of these products and prescribes airworthiness standards for the issuance of the type certificate, and changes to this type certificate, for a person-carrying VTOL aircraft in the small category, with lift/thrust units used to generate powered lift and control.

UAM Type Certification and Production Certification GCAA and FAA

- 2006 GCAA /FAA agreement with FAA
  - “Subject to the availability of resources, FAA will assist GCAA specialists in conducting GCAA type validation of U.S. aircraft.”
  - FAA will accept requests from U.S. civil aircraft manufacturers, on behalf of the GCAA, for GCAA type certification
- FAA two “Issue Papers” for UAS Type Certification
  - Available only to applicants
  - G-1 Type Certification Basis - UAS Streamlined Process
  - G-2 Determination of Compliance – Durability & Reliability Based Means of Compliance for TC of Low-Risk Drones

UAM Type Certification and Production Certification
FAA



Prescriptive Regulatory System	Performance-Based Regulatory System
Establishes specific technical requirements that must be met by applicants and approval holders	Establishes *outcomes* that must be achieved; allows flexibility in how the applicant or approval holder achieves those outcomes

Pros	Cons
Greater agility in accommodating innovation and new technologies	Defining requirements in terms of performance can be challenging.
Stronger focus on achieving the desired safety performance	Defining what compliance looks like can be difficult
Improved understanding of risks	Compliance planning requires more effort
Potential for stronger safety culture within regulator and industry	

UAM Type Certification and Production Certification FAA

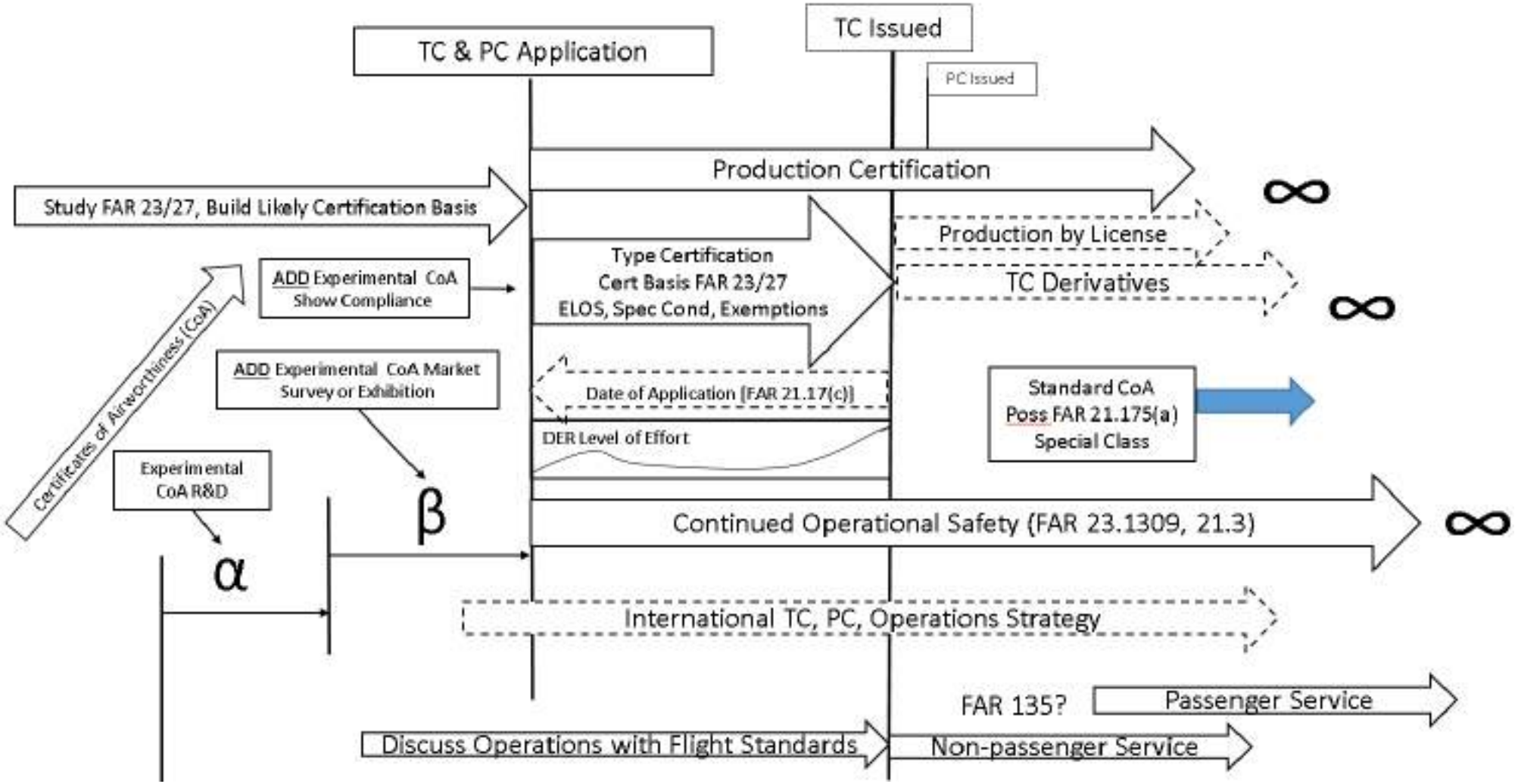
Part 23
+ Part 33, 35

Part 21.17(b)

Part 27
+ Part 33

Requirement	Relevant Documents	Gap	Relevant Activities
All Aircraft: Functional Hazards	FAA 23.1309-1E, AR 70-62, MIL-HDBK-516C	Identification of hazards, design methods to address hazards, and testing methods	ISO-21448 SOTIF
All Aircraft: Risk Assessment and Management	FAA Order 8040.4A, SAE ARP 4761, MIL-STD-882E	New flight modes and characteristics, unclear risk profiles	
Part 33/ CS-E: Electric Propulsion	ASTM F39.05 *Electric Propulsion Units*	Design and manufacture issues	Proposed Revision (WK47374)
Part 33/ CS-E: Electric Propulsion	ASTM F44.40 *Powerplant*	Integration issues for hybrid-electric propulsion	Proposed Revision (WK41136)
Part 33/ CS-E: Electric Propulsion	ASTM F39.05 *Electric Propulsion Units*	Energy storage systems	Proposed Revision (WK56255)
All Aircraft: Software Design Assurance	RTCA DO-178C	The methods are unable to handle the large number of states and decisions that autonomy algorithms can take	
Detect and Avoid (DAA)		Minimum Operational Performance Standards (MOPS) to specify DAA equipment to support BVLOS UAS operations in Class D, E, and perhaps G, airspace.	RTCA SC-228
Command and Control (C2)	RTCA DO-362	Normative performance standards for C2 link systems and constituent subsystems, including beyond radio line of sight (BRLOS)	

UAM Type Certification and Production Certification



UAM Type Certification and Production Certification *Challenges*

- ***No common, global certification basis***
- "The UAE will not only be the first country to allow operation of flying pilotless taxis, **it also will be a hub where such taxis are 'the safest'**," said Saif Mohammed Al Suwaidi, GCAA director-general.
  - REF: https://whatson.ae/dubai/2017/08/dubais-flying-taxis-safest-general-civil-aviation-authority/
- Manufacturers don't understand LOE and expertise required for TC
- Regulatory Agencies not keeping pace with Industry
- Technology moving forward but may not be ready to carry passengers

BUT IT IS COMING

UAM Autonomous Operations

- Autonomous UAM much longer to implement than ground transport.
- Start piloted proceed toward autonomy,
  1. UAM operations with pilot
  2. UAM autonomous operation with pilot/safety observer and back up
  3. Full UAM autonomous operation
  4. Command and Control Center
- Aviation authority guidelines for fully-autonomous ops more un-formed than autonomous cars
  - UAM autonomy years out.

UAS/UAM Air Traffic Control = UTM

- Current ATC practices too cumbersome
- Manage by exception – what not to do!
- Collaborative – A/W, Ops, ATC
- Concept of Operations and ORA

1. Augmented Visual Flight Rules
2. Dynamic Delegated Corridors
3. Automated Decision Support Services
4. Performance-Based Operations

- Command and Control Center
  - 3rd party service provider?
  - Clearance, flight tracking, weather
- Automated verification
- Low Altitude Interoperability
- Broadcast/Remote ID – automated verifications
- Detect and Avoid day and night/all weather
- GPS/Communications, Environmental

- ASTM F38 WG

Data Communications:
Key to Safe and Efficient UAM Flight Operations

- **Crucial Vulnerability: Security of In-Flight Data Transmissions**
  - UAM ops/public safety - continuous data comms between aircraft, control center and network.
  - Transmissions in open accessible airwaves; vulnerable to interception/corruption by hackers
  - Standard data encryption - adequate protection against unsophisticated hackers, but not dedicated hackers.
  - New data encryption technology, recently developed - KeyBITS.
    - Level of data security higher than all encryption.
  - Does not rely on algorithms, not susceptible to code-breakers.

- **Digital Encryption Problem: Rely on Complexity**
  - Algorithmic data encryption - complex rules to transform each bit in message.
  - Buries message enabled by modern computing power.
  - Derived from layers of rules - always underlying pattern: puzzle to be solved.
  - With powerful computers— code-breaker discerns pattern, decrypts message, and impacts communication.

Data Communications:
Key to Safe and Efficient UAM Flight Operations

- **Solution: Use Unbreakable Keys**
  - Not algorithmic - based on randomness and concealment.
  - Random encryption key (known as a “one-time pad” or “OTP”); sends key through same channel as message.
  - OTP - encryption of each character independent from rest.
  - OTP used for years but not practical for high-volume, high-speed digital communications - need for secure key delivery.
  - OTP systems rely on separate channels to prevent interception of both encrypted message and unique key.
  - KeyBITS’s method for delivering encryption keys securely via same channel as encrypted messages.

Don’t get hacked. The unique **KeyBITS** encryption technology hides your data transmissions under a cloak of “optical quantum noise”, disguising the signal, making it undecipherable and unhackable.

Heliport/Vertiport

- Heliports - single-point design;1 aircraft to land or takeoff
  - No provision for multiple / simultaneous ops
  - No parking, limited pax services.
- Limits # heliports for eVTOL ops or eVTOL retrofit
- eVTOL business model options:
  1. UAM provider own facility – Uber Air
  2. UAM provider owns facility but leases to firm that specializes in pax facilitation and ground handling.
  3. Mirror FBO - UAM provider leases space from existing infrastructure owner.
  4. Regulatory authority owns facility

Heliport/Vertiport
Existing Standards and Regulations?


U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Heliport Design

1. Purpose. This advisory circular (AC) provides standards for the design of heliports serving helicopters with single rotors. Apply basic concepts to facilities serving helicopters with tandem (front and rear) or dual (side by side) rotors, however many standards will not apply.

2. Cancellation. This AC cancels AC 150/5390-2B, Heliport Design, dated September 30, 2004.

3. Application. The Federal Aviation Administration (FAA) recommends the guidelines and specifications in this AC for materials used in the construction of heliports. In general, use of this AC is not mandatory. However, use of this AC is mandatory for all projects funded with Federal grant monies through the Airport Improvement Program (AIP) and with revenue from the Passenger Facility Charge (PFC). See Grant Assurance No. 34, Policies, Standards, and Specifications, and PFC Assurance No. 9, Standards and Specifications. For information about grant assurances, see http://www.faa.gov/airports/aip/grant_assurances/. The use of terms implying strict compliance applies only to those projects. Other federal agencies, states, or other authorities having jurisdiction over the construction of other heliports decide the extent to which these standards apply.

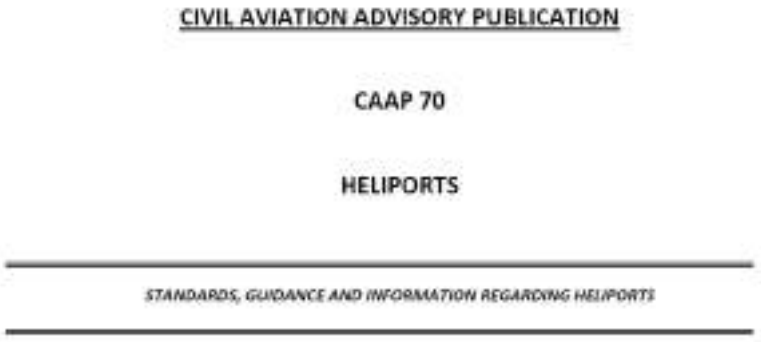
4. Principal changes.

a. Changed the term for the helicopter overall length (OL) to 'D' or 'D value.'

b. Added definitions for design loads for static and dynamic load bearing areas (LBA).

c. Added guidance for pavement or structure larger than the touchdown and lift-off area (TLOF), but less than the size of the final approach and take-off (FATO).

d. Added guidance for turbulence effects.


CIVIL AVIATION ADVISORY PUBLICATION

CAAP 70

HELIPORTS

STANDARDS, GUIDANCE AND INFORMATION REGARDING HELIPORTS


International Standards and Recommended Practices

Annex 14 to the Convention on International Civil Aviation

Aerodromes

Volume II
Heliports

International Civil Aviation Organization

Annex to ED Decision 2019/012/R

Certification Specifications and Guidance Material for the design of surface-level VFR heliports located at aerodromes that fall under the scope of Regulation (EU) 2018/1139

(CS-HPT-DSN)

Issue 1

23 May 2019

No policy guidance or regulatory mandates for Vertiport operations; no design standards, fire and building codes or best practices that speak to eVTOL infrastructure and requirements.

Heliport/Vertiport

- No certified eVTOL to provide performance data regulators need for regulations.
- To start April 3, 2019, FAA issued RFI to eVTOL industry to begin process
- Regulatory void.
  - Vast majority of Vertiports privately owned.
  - Allows owners flexibility in design and operation.
  - Provides stakeholders with some options should oversight or enforcement challenges arise.
- Example - new building near Vertiport within approach and departure path.
- Obstruction evaluation process makes determination whether proposed structure encroaches onto flight path - determination not enforceable.
- Also applies to public use airports, lack of oversight of Vertiports leaves operators with no one “in their corner” should situation arise.

Heliport/Vertiport
DESIGN AND PLANNING

- Vertiport operators operate as private facilities.
- Some exceptions eVTOL flights will originate and terminate at, Vertiports not airports.
- Business case for standardized design and construction – insurance driver etc. – A&E firms
- 3rd Party accreditation/audit – IBAC. IS-BAO, IS-BAH
- Charging stations – impact on grid – need for electrical substations – rooftop - parking garages or office buildings – fire safety codes - solar

Heliport/Vertiport
Emergency Response

- Aircraft Rescue and Firefighting (ARFF)
- Fire codes, mitigation equipment and procedures
- High voltage electrical charging systems, electrical storage systems or onboard aircraft batteries
- Personal protective equipment
- Medical equipment
- Emergency response procedures
- Removal of accident aircraft
- Building egress

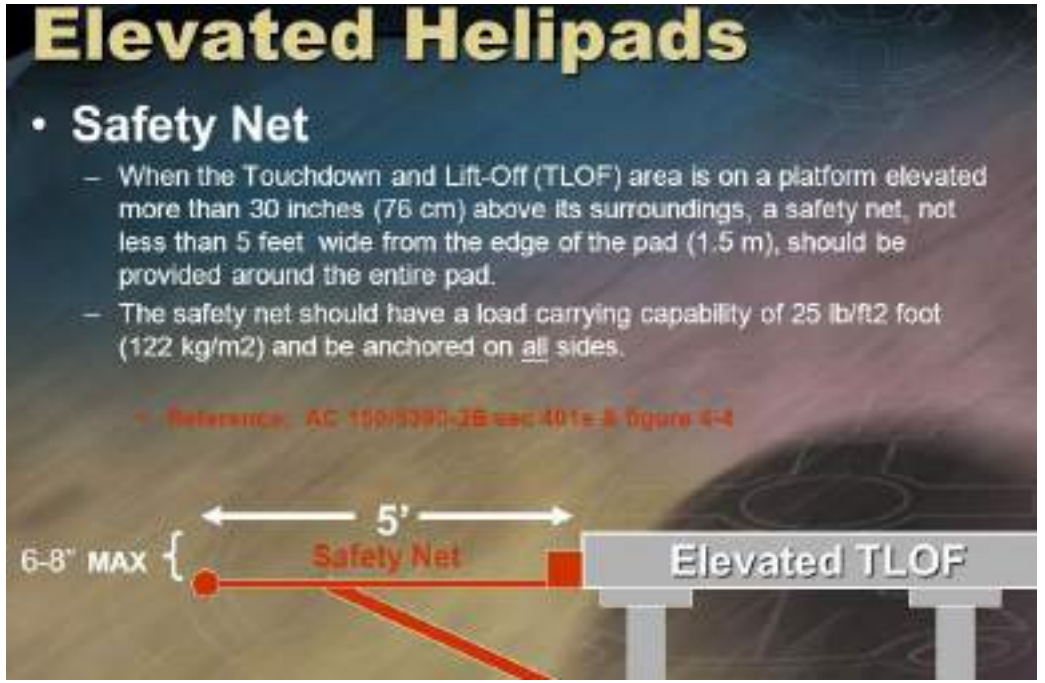
Heliport/Vertiport

Security

- Effective security programs tailored to specific ops
- FBO non sterile area
- Risk-based - start during design phase – minimize passenger impact
- Identify verification and screening
  - app-based user interface, integrated with non-invasive biometric like iris scan or facial recognition
- Subscribers and “ad hoc” users - different security protocols
- Twelve-Five Standard Security Program (TFSSP) & Private Charter Standard Security Program (PCSSP)

Heliport/Vertiport
Safety

- Safety Nets
- Signage and Marking
- Lighting
- Alternate or emergency power stations
- Emergency Response
- Egress
- Fire Stations
- Ground Handling and GSE
- Battery safety
- Flight Deck – USN flight deck expertise/model
- Rotor Blades
- Enable UAM-related reports and disaggregate data with to be useful policy tool
- Safety Management System



UAM Operator Certification – Part 135

- Aircraft under 12,500 lbs. MTOW , 4-6 passengers , Operate point-to-point
- New regulatory “part” for UAM is years-long process - unnecessary.
  - General parameters of UAM CONOPS + Part 135 authority best fit.
- UAMs would have several options for Part 135 compliance:
  - Obtain AOC from CAA
  - Obtain aircraft and provide to C/H (i.e. traditional aircraft management and membership groups)
  - Does not own or operate UAM but is broker/aggregator connecting passengers with carriers.
  - UAM provider contract for flights on specific schedule and resell to public. Flights operated under Part 135.
- Operations “on-demand”, Part 135 commuter or Part 121 carrier authority.
  - Part 135 commuter preferable - permits operating unlimited flights on schedule.
- Must Address
  - Operations Procedures and Safety Assurance System
  - Adding aircraft, pilots to the certificate
  - Maintenance manuals and controls
  - Pilot training programs
  - HAZMAT programs
  - Drug/Alcohol Testing
  - Economic authority
  - Insurance requirements and Public Charter and Broker Rules

U.S. Department of Transportation

Federal Aviation Administration

Air Carrier Certificate

This certifies that

has met the requirements of the Federal Aviation Act of 1958, as amended, and the rules, regulations, and standards prescribed thereunder for the issuance of this certificate and is hereby authorized to operate as an air carrier and conduct common carriage operations in accordance with said Act and the rules, regulations, and standards prescribed thereunder and the terms, conditions, and limitations contained in the approved operations specifications.

This certificate is not transferable and, unless sooner surrendered, suspended, or revoked, shall continue in effect indefinitely.

By Direction of the Administrator

Certificate number _____

Effective date _____

Issued at _____

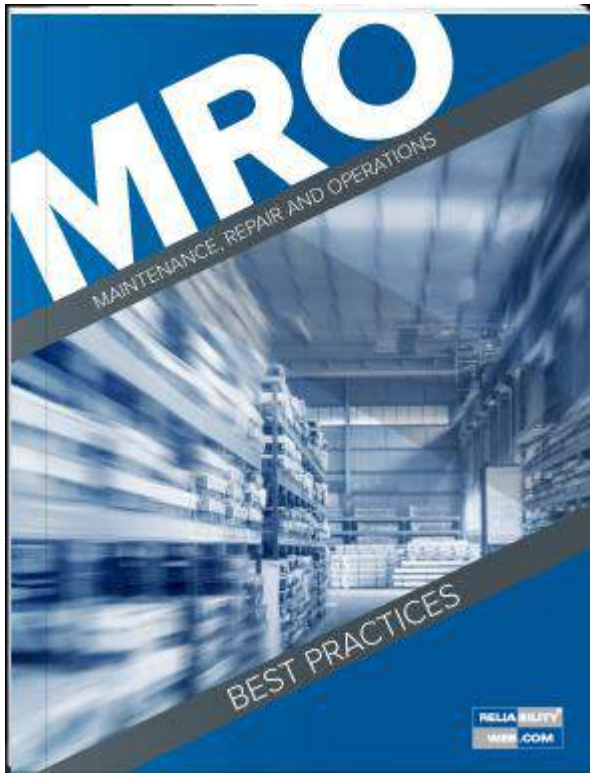
_____ (Signature)

_____ (Title)

_____ (Region/Office)

UAM MAINTENANCE, REPAIR, AND OPERATIONS

- UAM operator responsible for airworthiness of aircraft.
- Use certificated technicians to maintain aircraft IAW manufacturer's program.
- No plans to address maintenance technician certification for eVTOL aircraft.
- Use repairmen instead of A&P mechanics.
- Repairman only under §135.411(a)(2)30 - requires maintenance program, processes and systems similar to Part 121 operator.
  - Possibility of exempting autonomous aircraft from some requirements
- MROs provide mobile maint. and to perform maintenance away from location.
- UAM should consider work-away model, depending on size of eVTOL.
- UAM with autonomy could perform continuous reliability analysis, track and schedule maintenancewith remote assistance of operator's maintenance technicians. Can optimize routine support and increase flexibility of maintenance worksites.
- Elevated Vertiports pose challenges for maintenance accessibility.
- Repositioning disabled aircraft challenging if malfunctioning equipment renders aircraft incapable of flight, or ineligible for ferry permit.
- Can Vertiport accommodate movement of major components in and out of structure?

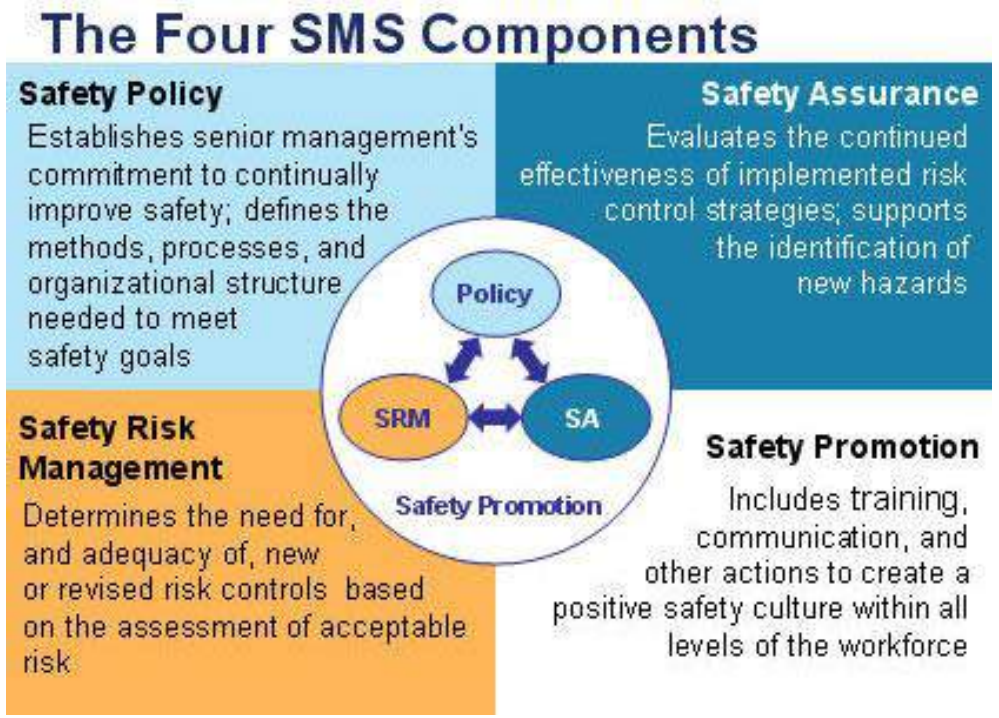


Intermodal Transportation Connectivity

- Provide seamless interface between ground and UAM systems.
- Landside and airside separated by facility that queues for departure.
- To provide arrival and departure points for communities & create + impression must have:
  1. Attractive, safe, efficient, comfortable, and familiar transfer of pax to and from UAM aircraft and modes of ground transportation.
  2. Basic service functions and designed facilities that will assist pax to and from air/ground transportation systems.
  3. Proper signage, access roadways, adequate/convenient parking, safe drop-off and pick-up areas, lighting, walkways & integrated security systems work together to facilitate safe and orderly flow of passengers.
  4. Terminal space and aircraft infrastructure requirements based on passenger/aircraft activity and location.
- UAM terminals in dense urban environments need more robust infrastructure then those located in suburban/rural environments.
- Benchmark - FBO industry specializes in planning, programming, designing, and managing GA passenger terminals to meet requirements, resulting in higher quality, lower life cycle costs, and increased sustainability.

Safety Management System

Imperative from Onset



5936 Maplewood Park Place
Bethesda, MD 20814
www.jdasolutions.aero
1-301-941-1460
info@jdasolutions.aero