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# UAS Certification – Regulatory and Operational WX Challenges for BVLOS

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# Topics

- Rain, Snow and Icing Hazards
- UAS Type Certification Process
- Operational WX Challenges



- Rain, Snow and Icing Hazards



# Unmanned Aircraft Systems – the rain hazard

- Water Ingress
  - Loss of control event in rain investigated by Air Accidents Investigation Branch (AAIB) Bulletin 1/2020, January 9, 2020, available at <http://www.aaib.gov.uk>
  - Service history of events including light drizzle
  - IP (International Protection or Ingress Protection) rating defined in International Electrotechnical Commission (IEC) standard 60529 is insufficient



# Unmanned Aircraft Systems – the rain hazard

- Aerodynamic
  - Low Reynolds Number
- Rain Erosion
  - Helical Tip Mach Number on sUAS can be same as on airplane propeller
- Effect on Essential Systems
  - Cameras and LiDAR don't work well with obscuration in air
  - Precipitation static (p-static) effect on communication systems?



# Unmanned Aircraft Systems – the snow hazard

- Snow effects on slow moving aircraft
  - Airships
  - sUAS



Snow encounter, 10 minutes, -2C to 0C

Credit: Meteomatics



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# Unmanned Aircraft Systems – the snow hazard

- Limitations of Automated Surface Observation
  - Inability of to report freezing drizzle
  - Inability to report freezing precipitation when falling snow is reported
  - DOT/FAA/TC-15/39 “Current Capabilities for Icing Nowcasting and Forecasting in the Terminal Area”
  - Case study in Appendix 1 of Advisory Circular 91-74A



# Unmanned Aircraft Systems – the icing hazard

- Icing occurs at low altitude





# Unmanned Aircraft Systems – the icing hazard

- Military experience
- Icing tunnel tests (credit: Meteomatics)



-2°C OAT



-5°C OAT



- UAS Type Certification Process

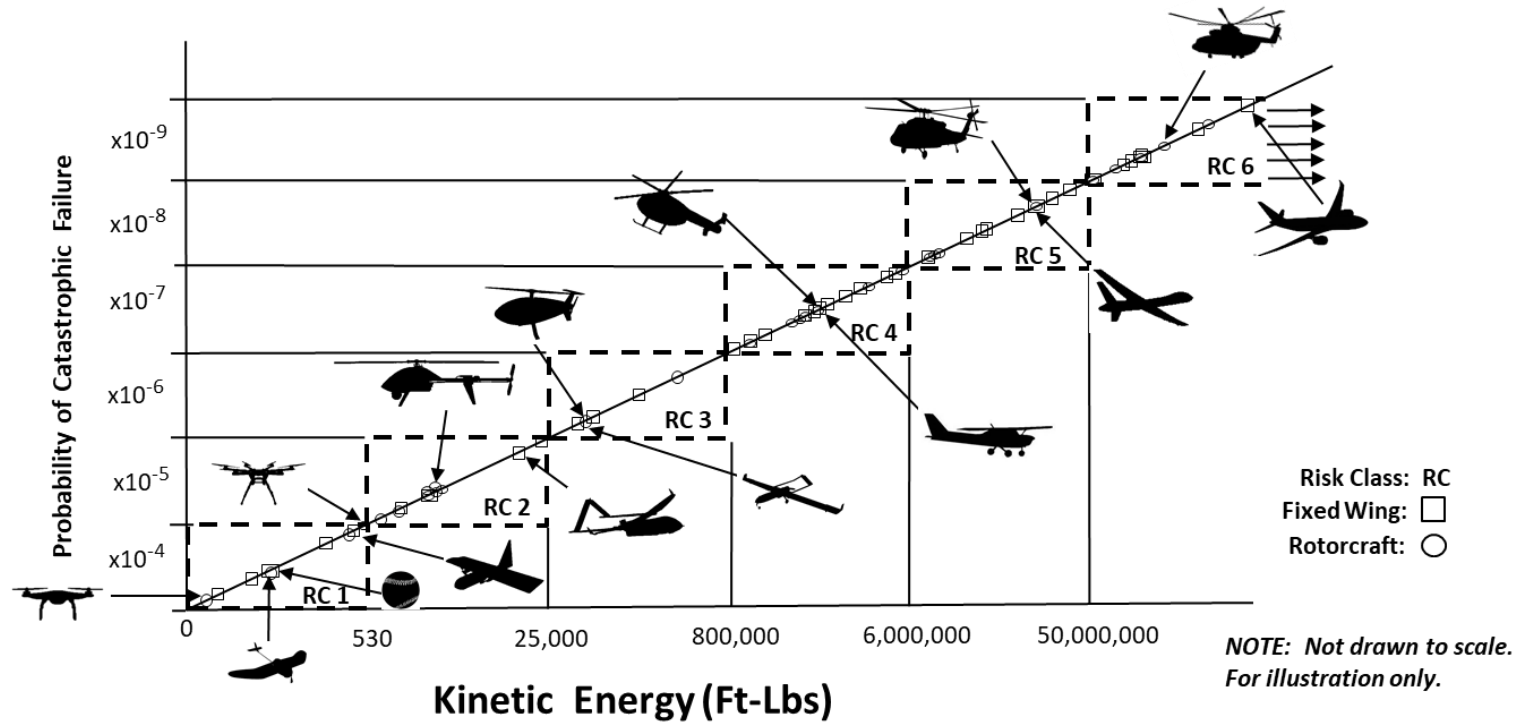


# Unmanned Aircraft Systems Rulemaking

- MOSAIC (Modernization of Special Airworthiness Certification)
- SUITE (Streamlined UAS Integration Type Certification Enaction)
  - Target goal of TC issuance within 90 days of application
  - Limited to:
    - no icing
    - Class 1-2 and possible population density limitations
    - <400 ft. AGL
    - electric only



# Risk Classification for UAS



# Proposed Certification Basis for Low Risk UAS

## UAS.130 Adverse Weather Conditions:

(a) For purposes of this section, adverse weather conditions means rain, snow, and icing.

(b) Except as provided in paragraph (c) of this section, the UAS must have design characteristics that will allow the UAS to operate within the adverse weather conditions specified in the CONOPS without loss of flight or loss of control.

(c) For adverse weather conditions for which the UAS is not approved to operate, the applicant must develop operating limitations to prohibit flight into known adverse weather conditions and comply with one of the following:

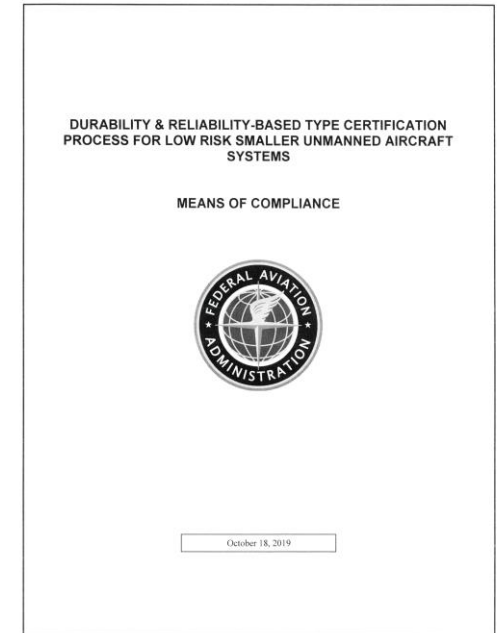
(1) Develop operating limitations to prevent inadvertent flight into adverse weather conditions; or

(2) Provide a means to detect any adverse weather conditions for which the UAS is not certified to operate and show the UAS's ability to avoid or exit those conditions.



# Means of Compliance for Low Risk UAS

- Means of Compliance
  - Design checklist (simple yes/no questions)
  - Endurance/Durability testing
    - Hours depend on ground risk, including whether design incorporates a flight termination system
  - Specific demonstration tests



# Proposed Means of Compliance for Low Risk UAS

## APPENDIX B – ICING, SNOW AND RAIN MEANS OF COMPLIANCE

The standard D&R-based means of compliance in this document do not currently accommodate operation in any precipitation or potential icing conditions. If applicants seek certification in any of these adverse weather conditions, coordinate with the FAA ACO Branch and Standards Branch for acceptable means of compliance for approval to operate in icing, snow or rain.

### Acceptable Means of Compliance

The UAS Flight Manual shall incorporate the following limitations:

**Takeoff is prohibited with any frost, snow, or ice on any surface of the UAS, including rotors and propellers.**

**Operations, including takeoff and landing, are prohibited in:**

- **Any precipitation (including drizzle, rain, snow, ice pellets); and**
- **Potential icing conditions (any moisture including clouds, precipitation, mist, fog, below an ambient temperature of +5°C)**



# Proposed Means of Compliance for Low Risk UAS

- Draft MOC Issue Paper presented to applicants
  - Moderate Rain
    - Waterproofness test of DO-160G, Category R
    - Flight tests
  - Snow
    - Simulated or natural snow tests
  - UFM (UAS Flight Manual)
  - ICA (Instructions for Continued Airworthiness)





# Proposed Certification Basis for Larger UAS

- Based on part 23, Amendment 23-64
  - Effective August 30, 2017
  - Replaced prescriptive design requirements with performance based airworthiness standards
    - Requirements moved to ASTM standards
    - ASTM F3120 “Standard Specification for Ice Protection for general Aviation Aircraft” is an acceptable MOC for part 23 airplanes
    - Supplemental MOCs
      - Ice detection
      - SLD detection
      - Flight tests maneuvers such as stall protection evaluation



# Areas needing additional research or investment from the icing community

- Weather products
- Ice detection systems
- Ice protection systems
- Ice accretion on rotors – performance, vibration, shedding
- Development of codes for rotor blade ice accretion
- Validation of codes at low speeds



# Questions?



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