

# UPRT in RPAS Considerations

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ICAO Regional Workshop on Loss of  
Control in-Flight and UPRT  
November 10-11, 2021



Federal Aviation  
Administration



# Background



Less than 55 lbs, not air carrier



55 lbs or more, not air carrier



Air carrier

# Background



Predominate now,  
so will talk about

Less than 55 lbs, not air carrier



55 lbs or more, not air carrier



Air carrier

# What I won't talk about

- **UAS 55 lbs and over, has separate regulations (49 USC 44807)**
  - several paths possible for operations (type certificate, exemption, special airworthiness certificate, public operations, etc.)
- **Air carrier, commercial delivery of packages has separate regulations (Part 135)**

# Now predominating UASs

- **Small UAS (Part 107)**

- < 55 lbs
- Keep within unaided sight
- One remote pilot, one drone
- < 400 ft AGL
- < 100 mph groundspeed
- Visibility > 3 miles
- Day only, unless remote pilot passes updated test and vehicle has anti-collision lights
- Operations in Class B, C, D, & E airspace require ATC authorization
- Need remote pilot certificate with small UAS rating (16 or older, pass a written-only test)
- Perform preflight inspection with comm link check
- Report any operation resulting in serious injury or property damage of \$500 or more to FAA within 10 days

# Now predominating UASs

- **...continued**
  - Register your vehicle (unless  $< 0.55$  lbs)
  - Limited exemption from rule for purely recreational purposes
  - To fly over people, it is category dependent
    - Category 1:  $< 0.55$  lbs; no laceration-causing-exposed-rotating parts; broadcast ID and location when over open-air assemblies
    - Category 2:  $>0.55$  lbs,  $< 55$  lbs, injury less than that caused by 11 ft-lbs of kinetic energy; same rotating parts restriction; same broadcast restriction
    - Category 3: now severity of injury less than 25 ft-lbs; cannot operate over open-air assemblies; can operate over people if closed site and everyone put on notice
    - Category 4: Issued a part 21 airworthiness certificate which includes over-people operation; maintenance; inspections; same broadcast restriction
  - No sustained flight over moving vehicles for Category 1, 2, 3

# Now predominating UASs

- **Operations not covered by Part 107 require a waiver that includes defined hazards, mitigations, and outcomes analyses (next slide)**

# FAA Order 8040.6

## Common Hazards and Mitigations

Hazards	Hazard Definition	Causes (if applicable)	Mitigations <sup>4</sup>	Outcomes
Technical Issue with UAS	Malfunction of any technical component of the UAS, which causes a deviation from planned operations.	<ul style="list-style-type: none"> <li>• Motor failure</li> <li>• Software failure</li> <li>• Hardware failure</li> <li>• Lost Link</li> <li>• GPS Failure</li> <li>• Communications failure</li> <li>• Flyaway</li> <li>• Geofence failure</li> <li>• Ground station failure</li> <li>• Battery/power failure</li> <li>• Avionics failure</li> <li>• UA leaves planned route</li> <li>• Failure of C2/3 change over</li> </ul>	<ul style="list-style-type: none"> <li>• Competent applicant/operator</li> <li>• UAS manufactured by competent or proven entity</li> <li>• UAS maintained by competent or proven entity</li> <li>• UAS developed to authority recognized design standards</li> <li>• C2/3 link performance appropriate</li> <li>• Preflight checks of UAS</li> <li>• Operational procedures validated</li> <li>• Remote crew trained and current</li> <li>• Safe recovery from technical issue</li> <li>• Methods to reduce kinetic energy</li> <li>• Ground population density</li> <li>• Emergency response plan in place</li> <li>• Reduce effects of ground impact</li> <li>• Technical containment in place and effective</li> <li>• Parachute or frangible aircraft</li> </ul>	<ul style="list-style-type: none"> <li>• Collision between UAS and a manned aircraft in the air</li> <li>• Collision between a UAS and person on ground or moving vehicle</li> <li>• Collision between a UAS and critical infrastructure on the ground</li> </ul>
Deterioration of external systems supporting the UAS operation	Malfunction of any component that is not a part of the UAS but supports safe operations.	<ul style="list-style-type: none"> <li>• ADS-B signal degradation</li> <li>• GPS signal degradation</li> <li>• UAS Traffic Management (UTM) failure</li> </ul>	<ul style="list-style-type: none"> <li>• Procedures are in place to handle the deterioration of external systems supporting the UAS operation</li> <li>• UAS is designed to manage the deterioration of external systems supporting the UAS operation</li> <li>• External services supporting the UAS operation are adequate to the operation</li> </ul>	<ul style="list-style-type: none"> <li>• Collision between UAS and a manned aircraft in the air</li> <li>• Collision between a UAS and person on ground or moving vehicle</li> <li>• Collision between a UAS and critical infrastructure on the ground</li> </ul>

# Example LOC-I concerns

- **Communication: loss of communication link**
  - Vehicles typically go into a safe-mode in hopes of re-establishing communications
- **Power: running out of battery**
- **Navigation: interference**
  - Can be “natural” loss being amongst high buildings
  - Can arise from GPS jammers (often illegal to operate...)
  - Now possible 5G transmitter issues
- **Other: unexpected upsets when the above are working**

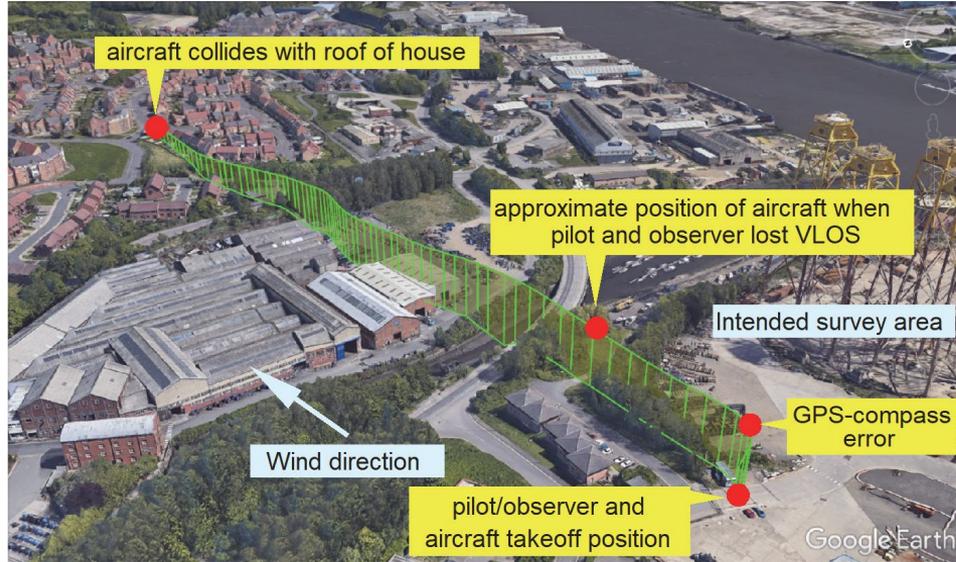
# Investigated accident



- **Interference**

- December 2019 in U.K.
- DJI Matrice M600 Pro in automated mode, lost GPS and crashed during construction site survey
- Vehicle then uses baro altitude to hover
- Operator usually takes over, but vehicle drifted out of range in wind before operators realized abnormal
- Maintained sea-level height, but rising ground caused it to eventually be at rooftop level, where it struck as house
- Fell into garden from ~20-ft height that could have caused serious injury or death
- Operator had required permissions
- Had not practiced for emergencies since 2018 flying training

# Investigated accident



# Another incident

- **January 2015**
- **2x2 ft DJI Phantom**
- **Operated by government intelligence agency employee at 3a.m.**
- **Spotted by on-duty White House officer**
- **Lost control from wind or tree**
- **Crashed blocks from White House**
- **Operator fully cooperated with authorities**
- **Said “flying it out the window was, in retrospect, a bad idea...”**



# Conversations with one operator

- **Operate under the small UAS rule**
- **Have a simulation to practice with (depth perception is hard)**
- **Practice maneuvering requiring several stick inputs**
- **Practice loss-of-control in-flight every 90 days**
  - Put in position mode, spin in direction you are not aware of, then have to recover
- **Said recurrency helpful, as “if you don’t use it, you lose it”**



# Conversations with one operator

- They set high battery threshold for operations
- Had external consultant (ConsortiQ) review operations (deemed to be model operation)
- OEM (DJI) has implemented “no-fly zones” in navigation (now 25 km around D.C.!)
- Some military areas can either take control of the UAS or disable with electromagnetic pulse
- They were surprised that one can get a license to operate without practical flying test



# Summary

- **Regulatory landscape divided by vehicle and operations**
- **Light UAS operations require only written test**
- **Practical skills, including loss-of-control training, left up to individual users**