

UPRT in RPAS Considerations

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Control in-Flight and UPRT
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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 ⁴	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"> • Motor failure • Software failure • Hardware failure • Lost Link • GPS Failure • Communications failure • Flyaway • Geofence failure • Ground station failure • Battery/power failure • Avionics failure • UA leaves planned route • Failure of C2/3 change over 	<ul style="list-style-type: none"> • Competent applicant/operator • UAS manufactured by competent or proven entity • UAS maintained by competent or proven entity • UAS developed to authority recognized design standards • C2/3 link performance appropriate • Preflight checks of UAS • Operational procedures validated • Remote crew trained and current • Safe recovery from technical issue • Methods to reduce kinetic energy • Ground population density • Emergency response plan in place • Reduce effects of ground impact • Technical containment in place and effective • Parachute or frangible aircraft 	<ul style="list-style-type: none"> • Collision between UAS and a manned aircraft in the air • Collision between a UAS and person on ground or moving vehicle • Collision between a UAS and critical infrastructure on the ground
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"> • ADS-B signal degradation • GPS signal degradation • UAS Traffic Management (UTM) failure 	<ul style="list-style-type: none"> • Procedures are in place to handle the deterioration of external systems supporting the UAS operation • UAS is designed to manage the deterioration of external systems supporting the UAS operation • External services supporting the UAS operation are adequate to the operation 	<ul style="list-style-type: none"> • Collision between UAS and a manned aircraft in the air • Collision between a UAS and person on ground or moving vehicle • Collision between a UAS and critical infrastructure on the ground

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**

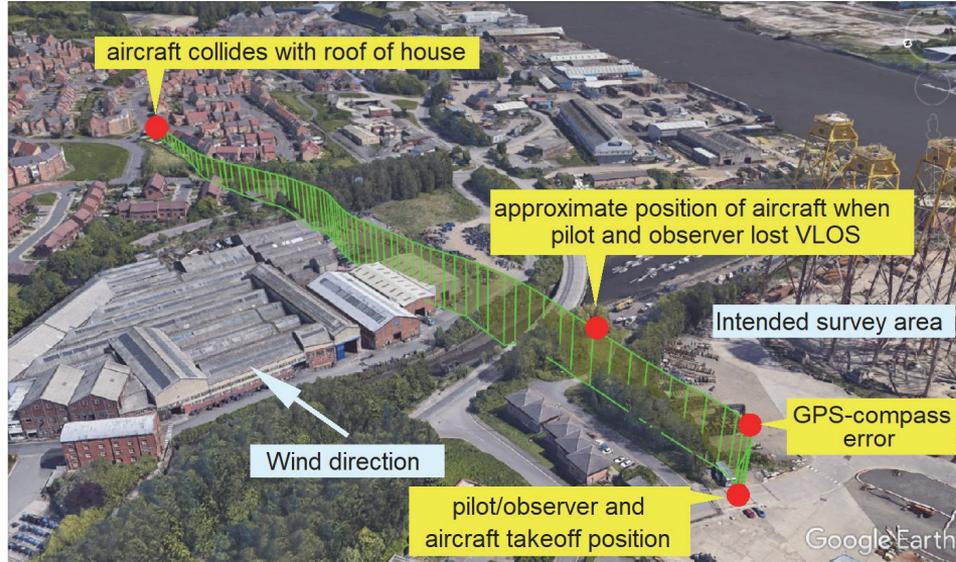
Investigated accident



- **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**