Autonomous Aerial Assistance for Search and Rescue

Team F

Standards and Regulations Presentation
March, 27, 2017

The team

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Sponsor:
Near Earth Autonomy

ASTM F3002 - 14a:

Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS)

What it is about

This specification is provided as a consensus standard in support of an application to a nation's governing aviation authority (GAA) for a permit to operate a small unmanned aircraft system (sUAS) for commercial or public use purposes.

Applicability

- All sUAS that are permitted to operate over a defined area and in airspace authorized by a Nation's GAA.
  Our drone is registered, and NREC is an allowable place for flying the drone

- One or more visual observers will provide for the sense and avoid requirement to avoid collisions with other aircraft.
  The team could be observers.

- Unless otherwise specified by a nation's GAA, this standard applies only to UA that have a maximum gross takeoff weight of 25 kg (55 lb) or less.
  The maximum takeoff weight of Matrice 100 is 3.6kg.

Main General Requirements

- All C2(Command and control) system and UA(Unmanned Aircraft) components shall minimize RFI(Radio Frequency Interference) so as not to degrade C2 link performance below acceptable levels.

- All C2 system electronic components shall be protected from impacts that may occur during normal operation.

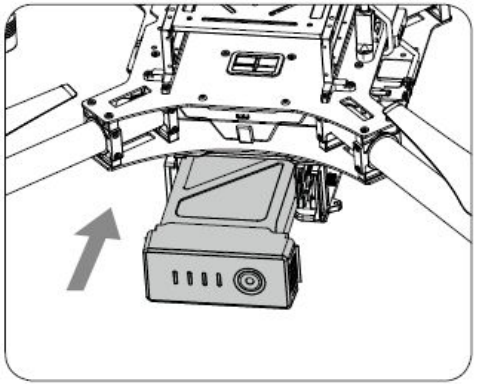
DJI Enhanced Spread Spectrum Technology

Matrice 100 Platform

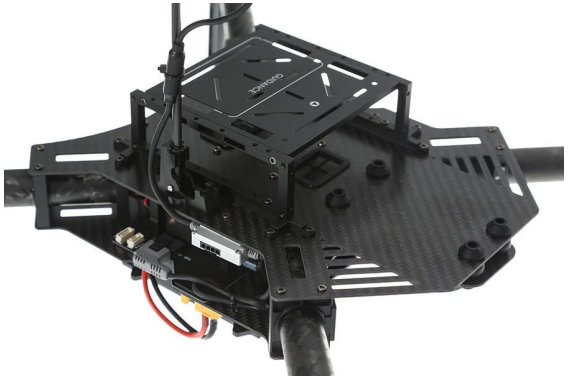
Main General Requirements

- Signal and power connectors for C2 electronic devices shall provide self-locking or positive locking connectors to ensure continuity of power and signal transmission during normal operation.

- The C2 system shall provide for mounting to a fixed surface using rigid or semi-rigid fasteners. (No strings, rubber bands, and glue)



DJI’s intelligent battery



Mounting surface of Matrice 100

Unmanned Aircraft

Requirements

- Response to lost link
- Ensure safe area
- Critical component safety and mounting

Matrice 100

- Response to lost link
  - Multiple options for return to home
    - Return to home
    - Land at current location
    - Return to GC location
- Ensure safe area
  - No fly zone
    - Height limits/Distance limits
- Critical component safety and mounting
  - GPS antenna unobstructed, foldable when not in use.

Ground Control Station

Requirements

- Data
- Visible GCS battery status
- Monitoring Link status
- Clean design interface for user operability

Matrice 100

- Data
  - GPS, altitude, horizontal/vertical velocities, pitch/yaw/roll
- Visible GCS battery status
  - 5 LEDs showing battery and a beep for low battery
- Monitoring Link status
  - LED indicator for link
- Clean design interface for user operability
  - Map interface showing aircraft location at all times

C2 Link

Requirements

- Connectivity with Ground station
- Secure Communication

Matrice 100

- Connectivity with Ground station
  - Status indicator
- Secure Access
  - Encrypted communication between UAV and ground station (AES)

ASTM F3005 - 14a:

Standard Specification for Batteries for Use in Small Unmanned Aircraft Systems (sUAS)

What it is about?

Defines the requirements for batteries used in small Unmanned Aircraft Systems (sUAS)

What it does not do?

- Define **requirements for the systems** in which battery packs are utilized
- Address all of the safety concerns: user’s responsibility

Terminology (1/3)

1. **C-rating:**
   Maximum steady-state current (amps) at which the battery cell or pack may be discharged without having pack temperature exceed the CTT of its constituent cell(s) or result in a reduction in cell life

2. **Characteristic Thermal Threshold (CTT):**
   The temperature beyond which a rechargeable battery cell will exhibit permanent deterioration of its critical performance parameters

3. **Depth of Discharge (DOD):**
   ratio of cell or pack capacity expended relative to its nominal capacity

Terminology (2/3)

4. **Pack:**
   a single cell or composition of battery cells connected in series or in parallel or both plus monitoring electronics, structure, and connector(s)

5. **Pack Assembler:**
   that supplier which performs the manufacturing processes that integrate the essential components into a functional pack

6. **Supplier:**
   any entity engaged in the design or production of a battery pack or any component of a pack intended for use in a sUAS

Terminology (3/3)

7. Small unmanned aircraft system, sUAS,:

Small unmanned aircraft (sUA) ✚ **All onboard systems & payload** ✚ **Control station, off-board systems** ✚ **Launch, recovery equipment** ✚ **Command & control links**

Batteries used in any of these subsystems shall comply with this standard unless failure of the battery will not compromise safety

Applicability

1. **Mandatory** at any point in the sUAS system in which batteries are used, except for payload downlinks that have no effect on flight safety

2. **For all sUAS** that are permitted to operate over a defined area and in airspace defined by a **nation's GAA**
   (maximum takeoff gross weight of 55 lb/25 kg, unless otherwise specified)

3. **Criticality** derived from safety risk analysis (in decreasing order):
   a. Loss of independent power for flight termination resulting in inability to terminate the flight safely
   b. Failure of primary power for the FCS resulting in loss of control to permit safe flight or recovery
   c. Failure of primary power for electric propulsion creating a ground impact hazard.

Main prescriptions

Divided into:

- Cells
- Mechanical Design and Assembly
- Electrical Design

Let’s take a look...

Main Prescriptions …*related to cells*

Responsibility of Cell Suppliers

Shall possess and provide:

- Process Control Plan
- Quality Assurance Plan
- Material Safety Data Sheet
- Technical Data Sheet
- Mark cell with Lot No. and supplier name

Responsibility of Pack Assembler

- **Lot testing:** Capacity test, Physical inspection
- **Received-Voltage test**
- **Records and certifications:**
  - Technical Data Sheet, MSDS for cells
  - Data items, by lot
  - Pack assembler's specified shipping/storage voltage
  - Lot no. -> Pack serial no.
  - Mfg. date
- **Pack Assembly Requirements**
- **Final test**

Main Prescriptions …*related to cells*

Responsibility of Pack Assembler

1. **Lot testing:** sample selected from each lot of cells
   a. Capacity test: one complete charge-discharge cycle
   b. Physical inspection: check for swelling, electrolyte leakage, out-grasping, odor, damage, etc.

2. **Received-voltage test:**
   a. Measurement made before any load/charge is applied to the cell
   b. Shall not vary significantly from the typical chemistry-specific storage/shipping voltage

3. **Final test:**
   a. Each completed pack shall be subjected to two charge-discharge cycles, following which the pack shall be charged to its appropriate, chemistry-specific shipping/storage voltage
   b. The pack shall demonstrate its rated capacity by means of this testing

Our application ...*related to cells*

Can't directly track cells

Applies only to the battery used for flight:

- Governed by the battery manufacturer: DJI

Found that DJI follows this standard:

- US DOT FAA document

The petitioner supports his request with the following information:

The petitioner has provided the following information – contained in his petition and supporting documentation including: (1) Phantom 2 user manual v1.4 (2) Phantom 2 Quick start guide (3) Turbo Ace Matrix manual vII (4) ASTM international manual F2500-07 standard practice for Unmanned Aircraft System (UAS) visual range flight operations (5) ASTM international manual F2910-14 Standard Specification for Design and Construction of a Small Unmanned Aircraft System (sUAS) (6) ASTM manual F2911-14 Standard Practice for Production Acceptance of Small Unmanned Aircraft System (sUAS) (7) ASTM manual F3002-14a Standard Specification for Design of the Command and Control System for Small Unmanned Aircraft Systems (sUAS) (8) ASTM manual F3003-14 Standard Specification for Quality

Assurance of a Small Unmanned Aircraft System (sUAS) (9) ASTM manual F3005-14a Standard Specification for Batteries for Use in Small Unmanned Aircraft Systems (sUAS)

Source:
https://www.faa.gov/uas/beyond_the_basics/section_333/333_authorizations/media/Innovative-Ventures-12102.pdf

Mechanical Design and Assembly

1. **In-Process Quality(Observable during visual scrutiny)**

   Make it conducive to be observed during the assemble process

2. **Cell Connection**

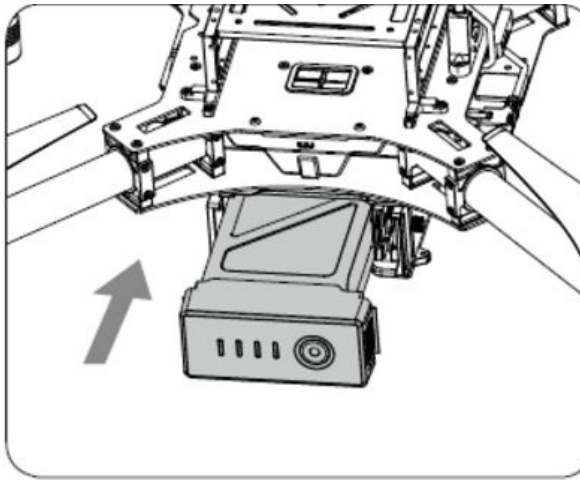
   Cells shall be interconnected using techniques that minimize failure caused by vibration and impact.

3. **Vibration**

   During flight not much vibration(battery casing), While landing, we have buffer below to lessen the vibration

4. **Puncture Resistance**

   PVC wrap



Mechanical Design and Assembly

5. Identification—Pack identification

1) Supplier
2) Capacity
3) Serialization
4) Safety Warnings
5) Recovery Identificat

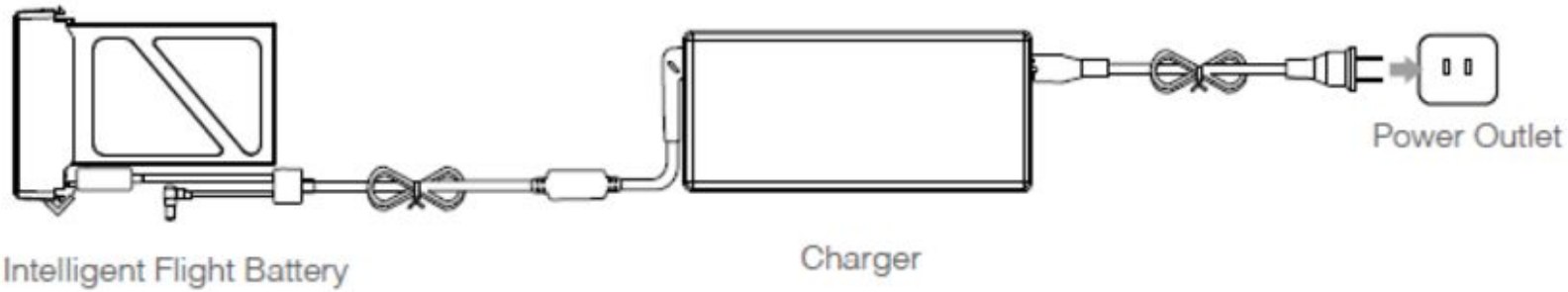
Electrical Design

1. Capacity
2. Charge
3. Wiring
4. Connectors
    a. Contacts
    b. Configuration
    c. Non-Electrical Materials
5. Node Access
6. Thermal Performance

1. 4500mAh(within 1 sigma)
2. 65%(0% not good for long-term storage)
4. Connectors
    a. Gold-plated
    b. Heavy Duty pins for power and smaller pins for the cell-balance nodes
    c. Non-Electrical Materials
5. No Node Access
6. Thermal Performance
    a. The battery will only charge when its temperature is between 0°C (32°F)and 40°C (104°F).
    b. Core temperatures below -10℃ is not advised

Maintenance

1. Charging (Specific battery chemistry)
2. Series-Cell Balancing
3. Temperature Change
4. Physical Inspection
5. Routine Evaluation
6. High/Low Utilization
7. Storage
8. Damage Evaluation
9. Disposal



Thanks!