Aircrew Operator’s and Maintenance Manual: DJI Phantom 2

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1. **Introduction**

The DJI Phantom 2 is a commercial hobby type UAS commonly used for photography and recreational use, and provides a stable platform for aerial photography. This document describes operating and maintenance procedures developed by the University of Nevada AirCTEMPs instrument center. This document is intended for AirCTEMPs aircrew familiar with the operations and maintenance of the DJI Phantom 2. The following DJI documents provide supplemental and more detailed information: PHANTOM 2 User Manual, PHANTOM Quick Start Manual, PHANTOM Flying Flowchart, and Ground Station Wireless Data-Link User Manual. New AirCTEMPs aircrew are encouraged to familiarize themselves with the above DJI documents before operation or maintenance, and during training.

1.1 **Phantom 2 Performance Specifications**

**Aircraft**
- Weight (including battery): 1000g
- Maximum takeoff weight: 1300g
- Operating temperature: -10°C to 50°C
- Max yaw (angular velocity): 200°/s
- Max tilt Angle: 35°
- Max ascent: 6m/s
- Max descent: 2m/s
- Max flight speed: 15m/s (not recommended)
- Max flight altitude: 6000m
- Max flight altitude A.G.L.: 122m (FAA regulations, Geofenced)
- Flight time: 20m (approximate)

**Radio Control**
- Frequency: 2.4GHz
- Control signal range: 1000m
- Receiver sensitivity: -97dBm

**Drone Smart Battery**
- Type: Lithium Polymer
- Weight: ~350g
- mAh: 5200
- Vdc: 11.1 (3 cell)

**Controller Battery**
- Type: Lithium Polymer
- mAh: 2000
- Vdc: 3.7V
2. **Operation Checklists**

2.1 **DJI Phantom 2 Pre-Mission Checklist**

___ Flight Log, Registration, Manual, Check lists
___ Firmware up to date, log book check
___ Airframe no cracks or separation
___ Motors free and no roughness
___ Motor Airframe and Accessory screws tight
___ Propellers and spares in good condition
___ Gimbal guards in place
___ Batteries half charge for transport, or full charge if mission imminent
___ Craft and control battery charger
___ Control switches, sticks, functioning
___ Camera SD card(s) cleared
___ Volt meter and battery connector

2.2 **Preflight Checklist**

Registration, Manual, Log, Com Radios (if applicable)

**Craft**

<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airframe and hardware</td>
<td>Check</td>
</tr>
<tr>
<td>Propellers</td>
<td>No nicks, cracks</td>
</tr>
<tr>
<td>Motors</td>
<td>Free</td>
</tr>
<tr>
<td>Flight battery</td>
<td>4 Lights, Voltage recorded</td>
</tr>
<tr>
<td>Flight battery</td>
<td>Install</td>
</tr>
<tr>
<td>Camera system</td>
<td>Check</td>
</tr>
<tr>
<td>Camera SD Card</td>
<td>Installed</td>
</tr>
</tbody>
</table>

**Control**

<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery</td>
<td>3-4 lights</td>
</tr>
<tr>
<td>Sticks</td>
<td>Full and smooth</td>
</tr>
<tr>
<td>Switches</td>
<td>GPS and Course</td>
</tr>
<tr>
<td>Antenna</td>
<td>45 degrees</td>
</tr>
</tbody>
</table>
### 2.3 Power-Up Checklist

<table>
<thead>
<tr>
<th>Check</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observer Check</td>
<td>Radio and Visual Check</td>
</tr>
<tr>
<td>Control</td>
<td>On</td>
</tr>
<tr>
<td>Flight battery</td>
<td>On</td>
</tr>
<tr>
<td>Compass</td>
<td>Calibrate if new location</td>
</tr>
<tr>
<td>Home point</td>
<td>Establish</td>
</tr>
<tr>
<td>Camera</td>
<td>Started</td>
</tr>
<tr>
<td>Take off Area</td>
<td>Clear for 5m</td>
</tr>
<tr>
<td>Flight Timer</td>
<td>Set at take off</td>
</tr>
</tbody>
</table>

### 2.4 Takeoff and Hover

<table>
<thead>
<tr>
<th>Check</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>All axis check</td>
</tr>
<tr>
<td>FPV</td>
<td>Check if installed</td>
</tr>
<tr>
<td>OSD</td>
<td>Check if installed</td>
</tr>
<tr>
<td>Telemetry Data Collection</td>
<td>Check</td>
</tr>
</tbody>
</table>

### 2.5 Landing and Shut Down

<table>
<thead>
<tr>
<th>Check</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landing area</td>
<td>Clear for 5m</td>
</tr>
<tr>
<td>Motors</td>
<td>Stopped</td>
</tr>
<tr>
<td>Camera</td>
<td>Stopped or Off</td>
</tr>
<tr>
<td>Flight Time</td>
<td>Recorded</td>
</tr>
<tr>
<td>Flight Battery</td>
<td>Power Off, Voltage recorded</td>
</tr>
</tbody>
</table>

### 2.6 Post Flight

<table>
<thead>
<tr>
<th>Check</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Battery</td>
<td>Off</td>
</tr>
<tr>
<td>Control</td>
<td>Off</td>
</tr>
<tr>
<td>Motors</td>
<td>Check and remove propellers</td>
</tr>
<tr>
<td>Airframe and Hardware</td>
<td>Check</td>
</tr>
<tr>
<td>Camera SD card</td>
<td>Removed and mission labeled</td>
</tr>
</tbody>
</table>
## 2.7 DJI Phantom 2 Common LED Codes

### Normal
- Red, Green and Yellow flashing sequentially and rising tone beep
- Start up and self-test

### GPS and Control Mode
- GPS Mode
- ATTI Mode

### GPS Status
- Control mode followed by GPS status
- GPS Mode, >6 Satellites
- GPS Mode, 6 Satellites
- GPS Mode, 5 Satellites
- GPS Mode, <5 Satellites

### Home Point
- Rapid green series Home Point Acquired.

### Compass Calibration: Toggle control from GPS to ATTI 6-12 times until constant yellow LED
- Constant Yellow
- Begin horizontal compass calibration
- Constant Green
- Begin vertical compass calibration
- Flashing Green
- Compass calibration successful
- Flashing Red
- Compass calibration error
- Alternate long red and yellow
- Compass error too great
- Rapid Flashing Yellow
- Lost radio link or Return to home
- Rapid Flashing Red
- Low battery warning

*For other error codes refer to Phantom 2 Quick Start Guide*
3. **Lost Link Procedures**

3.1 **DJI Lost Link Protocol**

DJI lost link protocol (failsafe) is initiated if control signal is interrupted or lost for a period of greater than 3 seconds. This will initiate either a land immediately or a return to home position which is set in the craft autopilot controller using the Phantom 2 Assistant Software. If signal is lost the craft will hover in place after 3 seconds the failsafe will initiate and the craft will land immediately or climb to 20 meters above the home point altitude and fly directly to the home point at this altitude and initiate an auto land. The default for AirCTEMPs Phantom 2 is return to home. If terrain between the takeoff (home) point and the flight course exceeds 20 meters the failsafe should be changed using the Phantom 2 Assistant Software to land immediately. The DJI flight controller does not provide a means of programming a remote lost link landing point.

3.2 **Home Point Establishment**

The PIC shall access the flight course to determine if terrain or obstacles are within the course area exceed 20 meters above the launch point. If there are any terrain or obstacles greater than 15 meters the failsafe mode should be changed to “land Immediately” using the Phantom 2 Assistant Software. If the flight course is clear of obstacles the PIC shall establish home point at the takeoff location. The DJI flight controller does not provide a means of programming a remote lost link landing point.

3.3 **Fly-Away**

The DJI flight controller failsafe mode is to land immediately or return to home. Because of this fly-away is unlikely to occur providing that proper start up procedures are followed and the craft is not launched before GPS satellite acquisition has occurred and home point has been established.

In the event of a suspected fly-away the craft should be monitored and if it appears the craft is not responding to controls, or does not appear to be following fail safe mode of land immediately or return. ATC shall be notified of the last position and altitude and heading of the craft, and of the approximate flight time remaining.

3.4 **Recovery**

All reasonable efforts shall be made by the flight crew to recover lost aircraft, with crew safety a priority.

3.5 **Imminent Crash**

If all attempt to regain control fail and a crash is Imminent. PIC is to first: attempt to, if at all possible, steer the UAS away from bystanders and other field workers. Second: audibly communicate to any nearby workers or bystanders of the imminent crash, forcing all nearby personnel and bystanders to keep their eyes on the UAS if possible.
4. **Maintenance**

4.1 **Introduction**

Because the DJI Phantom 2 is powered by electric motors and lithium polymer batteries, and the manufacture DJI does not have a specified TBO or specified periodic maintenance, UNR AirCTEMPs conducts physical inspection of craft pre- and post-flight and post-/mission for any mechanical defects or indication of ware or aging of the airframe and components. Since flights are of a duration of approximately 20 minutes, because of battery capacity, problems with propulsion motors such as indications of bearing ware should be evident on inspection and initial power up. Also because of the short duration of flight, motors have a low likelihood to fail catastrophically during flight. Because this is a multi-rotor VTOL craft and does not have control surfaces, there are no moving parts or actuators other than the flight motors that require inspection or for ware or function. The lithium polymer battery life expectancy is dependent on charge and discharge rates and storage practices, and have an unpredictable life expectancy. To predict battery replacement interval, the voltage of each battery shall be recorded in a battery log along with the flight time.

4.2 **Inspection and Maintenance Procedures**

UNR AirCTEMPs Phantom 2 is to be inspected by the PIC pre- and post-flight and pre- and post-mission by the AirCTEMPs Technician.

**Pre-and Post-mission Inspection**

_____ **Static Start Up**

Remove gimbal locks. Remove propellers or secure aircraft landing gear to test bench. Start aircraft and ensure indicator lights and annunciators are functioning. Arm motors and listen for uniform idle operation.

_____ **Control**

Test control sticks for correct motor response. Test function of controller switches, and sticks.

_____ **Firmware**

Check last firmware update in log book and confirm firmware is current version. Update as needed.

_____ **Airframe**

Ensure airframe has no cracks or separation. Replace airframe shell or other components if cracks are detected. Shell separation may be due to miss alignment and may snap into place with slight pressure. Confirm that shell separation is not due to missing or loose screws or hardware, and replace any damaged components.
Motors

Motors free and no roughness. Inspect motors visually for any debris between rotor and stator. Place propeller on motor and spin with finger to confirm motors turn freely with slight detent due to motor magnets. Any grinding, ticking or squeaking sound may indicate debris in the motor or worn bearing. Clean or replace motor as necessary.

Propellers

Inspect primary propellers and spares for cracks chips or nicks. Replace cracked or chipped propellers. Small nicks may be sanded or burnished, however it is advisable to replace rotors with even slight defects.

Gimbal

Inspect gimbal for free movement and put guards in place.

Batteries

Confirm batteries are at half charge for long term storage or full charge if mission is imminent.

Tablet

Check tablet for current flight app. version.

Accessories

Check flight, controller and tablet battery chargers cables and connectors.

Test Flight

Schedule test flight if control systems, propulsion motors or airframe components have been replaced, or if firmware has been upgraded.

4.3 DJI setup utilities

DJI provides two PC based utilities for setup and updating firmware of the Phantom 2 and controller.

Phantom 2 Assistant Software is used for setup and updating the DJI NAZA auto pilot system.

Phantom RC Assistant Software is used for setup and updating the control system.

DJI WIN Driver Installer may be required for the PC to recognize the Phantom 2 and the controller.