AirCTEMPs

Mission Planning, Policy and Safety Checklists

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Introduction

The purpose of this document is to amalgamate standard practices and procedures for AirCTemps UAS missions. Inside are a series of working documents that both cover the scope regulatory compliance and offer a pragmatic usefulness in mission planning. Forms ranging Certificate of Authorization (COA) forms to regulatory mission documentation logistics to simple pre-departure and pre-flight checklists and procedures are outlined in the following page. The end of the document includes a series of web links to manufacturer documentation on the four platforms outlined in the Air Operations and Maintenance Manuals, as well as a series of useful links on general UAS safety and sources on the ever-changing UAS regulatory landscape.

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Aircrew Operator's and Maintenance Manual: DJI Phantom 2

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

Airframe and hardware	Check
Propellers	No nicks, cracks
Motors	Free
Flight battery	4 Lights, Voltage recorded
Flight battery	Install
Camera system	Check
Camera SD Card	Installed

Control

Battery	3-4 lights
Sticks	Full and smooth
Switches	GPS and Course
Antenna	45 degrees

2.3 Power-Up Checklist

Observer Check	Radio and Visual Check
Control	On
Flight battery	On
Compass	Calibrate if new location
Home point	Establish
Camera	Started
Take off Area	Clear for 5m
Flight Timer	Set at take off

2.4 Takeoff and Hover

Controls	All axis check
FPV	Check if installed
OSD	Check if installed
Telemetry Data Collection	Check

2.5 Landing and Shut Down

Landing area	Clear for 5m
Motors	Stopped
Camera	Stopped or Off
Flight Time	Recorded
Flight Battery	Power Off, Voltage recorded

2.6 Post Flight

Flight Battery	Off
Control	Off
Motors	Check and remove propellers
Airframe and Hardware	Check
Camera SD card	Removed and mission labeled

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.

Aircrew Operator's and Maintenance Manual: DJI Phantom 3

1. Introduction

The **DJI Phantom 3** 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 CTEMPs aircrew familiar with the operations and maintenance of the DJI Phantom 3. The following DJI documents provide supplemental and more detailed information: Phantom 3 Quick Start Guide, Phantom 3 Advanced User's Manual, Phantom 3 Intelligent Flight Battery Safety Guidelines, Phantom 3 Safety Guidelines and Disclosure. New AirCTEMPs aircrew are encouraged to familiarize themselves with the above DJI documents before operation or maintenance, and during training.

1.1 Performance Specifications

Aircraft	
Weight (including battery)	1280g
Operating temperature	0°C to 40°C
Max ascent	5m/s
Max descent	3m/s
Max flight speed	16m/s (ATTI mode, no wind)
Max flight altitude	6000m
Max flight altitude A.G.L.	122m (FAA regulations, Geofenced)
Flight time	23m (approximate)
Radio Control	
Frequency	2.4GHz
Control signal range	2000m
Receiver Sensitivity	-101dBm
Drone Smart Battery	
Type	Lithium Polymer
Weight	365g
mAh	4480
Vdc	15.2 (4 cell)
Controller Battery	
Type	Lithium Polymer
mAh	6000 (4 Cell)
Vdc	7.4 (working voltage)

2. Operation Checklists

2.1 DJI Phantom 3 Pre-Mission Checklist

___ Flight Log, Registration, Manual, Check lists, Com Radios

___ 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, tablet mount functioning

___ Primary and backup tablet check and map(s) cashed

___ Tablet charger

___ Primary and spare USB cable

___ SD card(s) cleared and firmware up to date

2.2 Preflight Checklist

Registration, Manual, Log, Com Radios

Craft

Airframe and Hardware	Check
Gimbal	Locks removed and gimbal free
Propellers	No nicks, cracks
Motors	Free
Flight Battery	4 Lights, Voltage recorded
Camera SD Card	Installed

Control

Battery	3-4 lights
Sticks	Full and smooth
Mode Switch	Check and in P
Tablet	Attached, screen clean
Antenna	45 degrees

2.3 Power Up Checklist

Control	On
Tablet	On
Flight Battery	On
Connection Established	Check
Data Channel	Check and set
Compass	Calibrate if new location
Flight Battery	Record voltage
Home Point	Establish
Take off Area	Clear for 5m

2.4 Takeoff and Hover

Taking off Home Point	Audio check
Controls	All axis check
Video Link	Check
Telemetry Data Collection	Check
Camera Gimbal	Check
Camera	Start

2.5 Landing and Shut Down

Camera	Stop
Landing Area	Clear for 5m
Motors	Stopped
Battery and Flight Time	Recorded
Flight Battery	Power Off

2.6 Post Flight

Flight Battery	Off
Control	Off
Motors	Check and remove propellers
Gimbal	Install locks
Airframe and Hardware.	Check
Camera SD card.	Removed and mission labeled.

2.7 DJI Phantom 3 Common LED Codes

Normal

	Red, Green and Yellow Flashing sequentially	Start up and self-test
	Green and Yellow flashing alternately	Warming up
	Slow green flash	Safe to fly **P** mode with GPS
	Two Green flashes	Safe to fly **P** mode no GPS
	Yellow flashing	Safe to fly **A** mode no vision or GPS

Warning

	Fast Yellow flashing	Lost control signal
	Slow Red flashing	Low battery warning
	Fast Red flashing	Critical battery warning
	Alternate Red flashing	IMU error
	Solid Red	Critical error
	Red and Yellow flashing alternately	Compass calibration needed

For other error codes refer to Phantom 3 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 a return to home position at a specified altitude which is set in the MODE > Advanced Settings > Failsafe mode on the controller tablet. If signal is lost the craft will hover in place after 3 seconds the failsafe will initiate and the craft will climb to the preset altitude AGL above the home point altitude and fly directly to the home point at this altitude and initiate an auto land. Note, the aircraft will stop its ascent to this altitude and return to home immediately if the throttle stick is moved during fail safe. 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. If there are any terrain or obstacles ensure that the return to home altitude is set to clear these obstacles. To set or check the return to home flight altitude (AGL above home point) enter MODE > Advanced Settings > Failsafe mode. Note the aircraft will stop its ascent to this altitude and return to home immediately if the throttle stick is moved during fail safe. 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 3 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 and the percent battery remaining as indicated on the tablet display.

4.2 Inspection and Maintenance Procedures

UNR AirCTEMPs Phantom 3 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**

Airframe 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.

_____ **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.

Aircrew Operator's and Maintenance Manual: 3D Robotics SOLO

1. Introduction

The **3D Robotics (3DR) SOLO** 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 with the help of the University of Nevada AirCTEMPs instrument center. This document is intended for AirCTEMPs aircrew familiar with the operations and maintenance of the 3DR SOLO. The following 3DR documents provide supplemental and more detailed information: SOLO Quick Start Guide and the SOLO User's Manual; which contains a section on safety procedures. New AirCTEMPs aircrew are encouraged to familiarize themselves with the above DJI documents before operation or maintenance, and during training.

1.1 3DR SOLO Performance Specifications

Aircraft

Weight (including battery)	1500g
Weight (including battery, gimbal, GoPro)	1800g
Max Payload	420g
Max ascent	10m/s *stabilize* mode, 5m/s *fly* mode
Max descent	10m/s *stabilize* mode, 5m/s *fly* mode
Max flight speed	15m/s *fly* mode
Max flight altitude	6000m
Max flight altitude A.G.L.	122m (FAA regulation, Geofenced)
Flight time	20 – 25 minutes (approximate)
Motors	880kV

Radio Control

Frequency	2.4GHz
Control signal range	800m (factory standard) (~0.5 miles)
Communication	3DR Link secure WiFi network

Drone Smart Battery

Type	Lithium Polymer
Weight	0.50 kg (~1.1 lb)
mAh	5200
Vdc	14.8 (4 cell)
Charging Time	~1.5 hours

Controller Battery

Type	Lithium Ion
mAh	2600
Vdc	7.2 (rechargeable)

2. Operation Checklists

2.1 3DR SOLO Pre-Mission Checklist

___ Flight Log, Registration, Manual, Check lists, Com Radios

___ Firmware up to date, log book check

___ Airframe: no cracks or separations.

___ Motors free and no roughness; only slight detent

___ Motor Airframe and Accessory screws tight

___ Propellers and spares in good condition, tightened

___ Gimbal guards in place (when applicable)

___ Batteries half charge for transport, or full charge if mission imminent

___ Battery chargers (Smart battery, controller battery, tablet battery)

___ Control switches, sticks, tablet mount functioning

___ Primary and backup tablet check and map(s) Pre-fetched

___ Primary and spare USB cable

___ SD card(s) cleared

___ Firmware up to date

2.2 Preflight Checklist

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

Craft

Airframe and Hardware	Check
Gimbal	Locks removed and gimbal free
Propellers	No nicks, cracks Check to make sure props are on correct motors (black to black, silver to silver)
Motors	Free
Flight Battery	5 Lights, Voltage recorded
Camera SD Card	Installed

Controls

Battery	at least 50% charge
Sticks	Full and smooth
Controller Display	Check
Tablet	Attached, screen clean

Antenna	45 degrees

2.3 Power-Up Checklist

Control	On
Tablet/laptop	On
Flight Battery	8 LED's lit in sequence, then all lit
Connection Established	Check
GPS lock	Check
Data Channel	WiFi Connection established
Compass	*Calibrate if new location
Home Point	Established when SOLO starts up. Check
Take off Area	Clear for 5m
Camera	Connected, transmitting (if applicable)

2.4 Takeoff and Hover

Taking off Home Point	Check (auto created by Mission Planner)
Controls	Check digital display (battery, GPS, WiFi…)
Telemetry Data Collection	Check
Video Link	Check
Camera Gimbal	Check
Camera	Start

2.5 Landing and Shut Down

Camera	Stop
Landing Area	Clear for 5m
Motors	Stopped
Battery Voltage and Flight Time	Recorded
Flight Battery	Power Off

2.6 Post Flight

Flight Battery	Off (too hot?)
Control	Off
Motors	Check and remove propellers
Gimbal	Install locks
Airframe and Hardware	Check
Camera SD card	Removed and mission labeled.

2.7 3DR SOLO Common LED Codes

LED lights are under each arm, at the base of the leg attachments

Light Sequences

Solid White (front and back)	Ready to fly: standard flight configuration
Pulsing white and red	Under Auto Pilot Control
Flashing red, alt. front and back	Controller Signal Lost
Flashing Rainbow	Update in Progress
Solid Green: then turning off one by one	Startup Successful
Sold green without turning off automatically	Startup Unsuccessful, restart SOLO

3. Lost Link Procedures

3.1 Emergency Procedure Features with SOLO

Pause

Allows you to stop SOLO in its current position in the air. Stays until further commands given.

Use to: -prevent hitting an object
-reorient
-only works with GPS lock

Regaining Manual Control

Always have controller in hand. If, for any reason during otherwise automated flight, manual (standard) control is needed. Use the fly  button.

Return Home

Use this to automatically force SOLO to return home, so long as GPS is locked.

Use when: -low battery indicated on controller shows
-quick, unexpected end to flight needed
-DOES NOT AVOID OBSTACLES WHEN THIS FEATURE USED. Need standard flight and manual control to do this.

Land

Press and hold  to land SOLO directly under its current position.
Can work without GPS lock, but drift can occur.

Emergency Motor Shut-off

Simultaneously hold down the A, B and Pause Buttons. LAST RESORT.

3.2 Controller Signal Loss

An automatic failsafe procedure is programmed into the SOLO, so that in the event of controller signal loss, the "Return Home" feature is automatically enabled. If controller signal is regained, PIC has the option to regain control by pressing the  button.

3.3 Home Point Establishment

The PIC shall access the flight course to determine if terrain or obstacles are within the course area. If there are any terrain or obstacles ensure that the return to home altitude is set to clear these obstacles. The PIC shall establish home point at the takeoff location, which, if using Mission Planner software, is done automatically; the home point is designated at the location of quad start up.

If flying without GPS lock, DO NOT use return to home feature, even if, during the flight, the drone re-acquires a GPS lock. If in this case, the drone acquires a GPS lock, it will make its first lock location the return-to-home location, which can be potentially dangerous.

3.4 Fly-Away

The 3DR 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, after above-mentioned attempts to correct the errant flight have been attempted, 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.

3.5 GPS Signal Loss

SOLO will automatically switch to manual flight mode if a GPS signal is lost. NOTE: because a GPS signal is lost, SOLO will not maintain a position when the right joystick is released.

If GPS is lost, attempt to immediately land and wait for GPS signal to reconnect.

If a secondary error occurs (low voltage, signal loss) the drone will initiate an immediate landing procedure at current location.

3.6 Battery Alerts

Controller display will give a battery warning at 25% and 10%. At 5%, SOLO will immediately initiate the “Return to Home” program.

DO NOT let battery reach 0%, as this will ruin the battery.

Plan mission in order to land with a minimum 25% charge.

Controller Battery charge will also display when low; at 10%, 5% and 0%. If controller battery goes below 5%, “return to home” program will be initiated by the drone automatically.

Plan mission in order to before controller battery reaches 10%.

3.7 Recovery

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

3.8 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 3DR SOLO is powered by electric motors and lithium polymer smart batteries, and the manufacture 3DR does not have a specified TBO or specified periodic maintenance, 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 and the percent battery remaining as indicated on the tablet/laptop display.

4.2 Inspection and Maintenance Procedures

UNR AirCTEMPs SOLO 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 (see Appendix for web link)

_____ **Firmware**

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

_____ **Airframe**

Ensure airframe has no cracks or separations. 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/Laptop**

Check tablet/laptop for current flight app. version.

_____ **Accessories**

Check flight, controller and tablet/laptop 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.

Aircrew Operator's and Maintenance Manual: Turbo Ace MATRIX

1. Introduction

The **Turbo Ace MATRIX** 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 with the help of the University of Nevada AirCTEMPs instrument center. This document is intended for AirCTEMPs aircrew familiar with the operations and maintenance of the Turbo Ace MATRIX. The following Turbo Ace documents provide supplemental and more detailed information: Turbo Ace MATRIX User's Manual and the NAZA-M LITE GPS User's Manual.

1.1 Turbo Ace MATRIX Performance Specifications

Aircraft	
Weight (excluding battery)	2180g
Max Payload	1500g (battery weight dependent)
Optimal Payload	1130g
Max yaw (angular velocity)	200°/s
Max tilt Angle	45°
Max ascent	6m/s
Max descent	6m/s
Max flight speed	27m/s
Max flight altitude A.G.L.	122m (FAA regulation, Geofenced)
Flight time	(assuming 22000mAh) 40 mins max
Radio Control	
Frequency	2.4GHz
Operating Temperature	-10.0°C – 50.0°C
Working Voltage Range	7.2V – 22.2V
Drone LiPo Battery	
Type	Lithium Polymer
Weight	~2500g
mAh	22000
Vdc	14.8 (6 cell)

2. Operation Checklists

2.1 Turbo Ace MATRIX Pre-Mission Checklist

___ Flight Log, Registration, Manual, Check lists, Com Radios

___ Firmware up to date, log book check

___ Airframe: no cracks or separations

___ Folding arms in good condition

___ Motors free and no roughness; only slight detent

___ Motor Airframe and Accessory screws tight

___ Battery Velcro support straps in good condition

___ Propellers, spares in good condition, tightened

___ Gimbal guards in place (when applicable)

___ Batteries half charge for transport, or full charge if mission imminent

___ Battery chargers (LiPo battery, controller battery, laptop battery)

___ Control switches, sticks

___ Primary and backup laptop check and map(s) Pre-fetched

___ Primary and spare USB cables

___ SD card(s) cleared

___ Firmware up to date

___ Transmitter Calibrated

2.2 Preflight Checklist

Registration, Manual, Log, Com Radios

Craft

Airframe and Hardware	Check
Gimbal	Locks removed and gimbal free (if necessary)
Propellers	No nicks, cracks
	Propellers on correct motors (cw and ccw)
Battery	Strapped and secured
Center of Gravity	Check. If off, re-adjust battery
Gyro	Calibrated
Motors	Free, slight detent
Camera SD Card	Installed

Controls

Sticks	Full and smooth
Controller Display	Check
Laptop	Attached, screen clean
Antenna	45 degrees

2.3 Power-Up Checklist

Control	On
Laptop	On
Connection Established	Check
GPS lock	Check. Wait 2-3 minutes after power up
Data Channel	Check
Compass	Calibrate if in new location
Home Point	Establish
Take off Area	Clear for 10m

2.4 Takeoff and Hover

Taking off Home Point	Check (auto created by Mission Planner)
GPS fix	>6 satellites?
Controls	All axis check
Video Link	Check (if applicable)
Telemetry Data Collection	Check
Camera Gimbal	Check
Camera	Start

2.5 Landing and Shut Down

Camera	Stop
Landing Area	Clear for 10m
Motors	Stopped
Battery and Flight Time	Recorded
Flight Battery	Power Off

2.6 Post Flight

Flight Battery	Off (too hot?)
Control	Off, throttle down
Motors	Check and remove propellers
Gimbal	Install locks, remove camera
Airframe and Hardware	Check
Camera SD card	Removed and mission labeled.

3. Lost Link Procedures

3.1 MATRIX Lost Link Protocol

Turbo Matrix signal loss protocol, or fail-safe protocol, is initiated if control signal is interrupted or lost. This will initiate a return to home function. If signal is lost, the failsafe will initiate.

3.2 Controller Signal Loss

An automatic failsafe procedure is programmed into the MATRIX, so that in the event of controller signal loss, the “Return Home” feature is automatically enabled. See DJI Naza User’s Manual for steps on how to configure this feature.

3.3 Home Point Establishment

The PIC shall access the flight course to determine if terrain or obstacles are within the course area. If there are any terrain or obstacles, PIC must be aware that the return to home, though automatically established at startup if using Mission Planner software, function will not automatically avoid these features. The Turbo Ace flight controller does not provide a means of programming a remote lost link landing point.

3.4 Fly-Away

The Turbo Ace 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, after above-mentioned attempts to correct the errant flight have been attempted, 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.

3.5 Recovery

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

3.6 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 Turbo Ace MATRIX is powered by electric motors and lithium polymer batteries, and the manufacture Turbo Ace does not have a specified TBO or specified periodic maintenance, 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 25-30 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 and the percent battery remaining as indicated on the laptop display.

4.2 Inspection and Maintenance Procedures

UNR AirCTEMPs MATRIX 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 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 separations. 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. Remove GoPro for storage and transportation (post mission).

_____ **Batteries**

Confirm batteries are at half charge for long term storage or full charge if mission is imminent.
Check batteries for bloating. This in an indication of a failing LiPo battery. If battery shell is bloated, replace as soon as possible and do not continue use.

_____ **Laptop**

Check laptop for current Mission Planner/software updates. Ensure it is current.

_____ **Accessories**

Check flight, controller and laptop 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.

Aircrew Operator's and Maintenance Manual: Tarot 650

1. Introduction

The Tarot 650 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 with the help of the University of Nevada AirCTEMPs instrument center. This document is intended for AirCTEMPs aircrew familiar with the operations and maintenance of the Tarot 650. The following Turbo Ace documents provide supplemental and more detailed information: Tarot 650 User's Manual and the NAZA-M LITE GPS User's Manual.

1.1 Performance Specifications

Aircraft	
Weight (including battery)	2180g
Max. Payload	1500g (battery weight dependent)
Optimal Payload	1130g
Max yaw (angular velocity)	200°/s
Max tilt angle	35°
Max flight speed	15m/s
Max flight altitude A.G.L.	122m (FAA regulations, Geofenced)
Flight time	40min (assuming 22000mAh)
Radio Control	
Frequency	2.4GHz
Operating Temperature	-10.0°C - 50.0°C
Working Voltage Range	7.2V – 22.2V
Work Amperage	40A nominal with 70A max spike
Drone LiPo Battery	
Type	Lithium Polymer
Weight	~2500g
mAh	22000
Vdc	14.8 (6 cell)

2. Operation Checklists

2.1 Tarot 650 Pre-Mission Checklist

___ Flight Log, Registration, Manual, Check lists, Com Radios

___ NOTAM?

___ Prefetch imager of flight location for waypoint planning

___ Log Book Check. Firmware matches version in maintenance log?

___ Mission Planner Version matches maintenance log?

___ Airframe: no cracks or separations

___ Folding arms in good condition

___ Arm retention clips in good condition

___ Motors free and no roughness; only slight detent

___ Motor Airframe and Accessory screws tight

___ Battery Velcro support straps in good condition

___ Propellers, spares in good condition, tightened

___ Gimbal guards in place (when applicable)

___ Batteries half charge (3.85V) for transport, or full charge if mission imminent

___ Battery chargers (LiPo battery, controller battery, laptop battery, transmitter)

___ Control switches, sticks

___ Primary and backup laptop check and map(s) Pre-fetched

___ Primary and spare USB cables

___ Sony A5100 Camera functional (batteries, SD cards…)

___ Multispectral checklist (when applicable)

___ SD card(s) cleared

___ Transmitter Calibrated?

2.2 Preflight Checklist

Registration, Manual, Log, Com Radios

Craft

Airframe and Hardware Check

Gimbal	Locks removed and gimbal free (if necessary)
Propellers	No nicks, cracks, on correct motors (cw, ccw)
Battery	Strapped and secured
Camera	Mounted, secured
VHF Radio	On, tuned to local ATC
Center of Gravity	Check. If off, re-adjust battery
Gyro	Calibrated
Motors	Free, slight detent
Camera SD Card	Installed
Take off Pad	Placed

Control

Sticks	Full and smooth
Controller	Display Check
Laptop	Attached, screen clean
Antenna	45 degrees

2.3 Power Up Checklist

Control	On
Laptop	On
Video Monitor	On
Tx	On
Connection Established	Check
GPS lock	Check. Wait 2-3 minutes after power up
Data Channel	Check and set
Compass	Calibrate if new location
Home Point	Establish
Take off Area	Clear for 10m

2.4 Takeoff and Hover

Taking off Home Point	Check (auto created by Mission Planner)
GPS fix	>6 satellites. HDOP < 2.0m
Gyro, Controls	All axis check
Video Link	Check (if applicable)
Telemetry Data Collection	Check
Tx Range Check	Operation at 175ft
Arm Trigger	Armed (Solid Red)
Flight Mode Switch	Check
Flight Mode	“Hover”
Camera Gimbal	Check
Camera	Start

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Take off	Ascend to 20m
Attitude	Check all axes
Climb	To Mission Altitude
Mission	Initialize (when applicable)

2.5 Landing and Shut Down

Camera	Stop
Landing Area	Clear for 10m
Motors	Stopped
Battery and Flight Time	Recorded
Flight Battery	Power Off

2.6 Post Flight

Flight Battery	Off (too hot?)
Control	Off, throttle down
Motors	Check and remove propellers
Gimbal	Install locks, remove camera
Airframe and Hardware.	Check
Camera SD card.	Removed and mission labeled. Backup and transfer data
Battery status and Flight Time	Logged and Recorded
Airfraft Telemetry Logs	Backed up and downloaded

3. Lost Link Procedures

3.1 Tarot 650 Lost Link Protocol

Turbo Taro 650 signal loss protocol, or fail-safe protocol, is initiated if control signal is interrupted or lost. This will initiate a return to home function. If signal is lost, the failsafe will initiate.

3.2 Taranis X9D Radio Failsafe Procedure

An automatic failsafe procedure is programmed into the TAROT 650, so that in the event of controller signal loss, the "Return Home" feature is automatically enabled. Ardupilot Failsafe Webpage for steps on how to configure this feature.

Failsafe should trigger when:

RC transmitter is turned off
UAS travels beyond RC transmitter range (500 – 700m)
RC receiver power loss
Physical connection between flight controller and receiver is broken.

When Failsafe triggered:

If vehicle is not armed, nothing will happen
If armed, motors will disarm immediately if UAS is on ground or pilots has throttle set to zero in a stabilize or acro mode
If has GPS lock, RTL feature will be initialized (within 2 meters of home position)
If has no GPS lock, UAS will land.

Failsafe clears before landing, UAS will stay in the current flight mode. You will have to manually return to desired flight mode, or let failsafe complete is process.

3.3 Home Point Establishment

The PIC shall access the flight course to determine if terrain or obstacles are within the course area. If there are any terrain or obstacles, PIC must be aware that the return to home, though automatically established at startup if using Mission Planner software, function will not automatically avoid these features. The Turbo Ace flight controller does not provide a means of programming a remote lost link landing point.

3.4 Fly-Away

The Turbo Ace 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, after abovementioned attempts to correct the errant flight have been attempted, 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.

3.5 Recovery

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

3.6 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 Taro**t** 650 is powered by electric motors and lithium polymer batteries, and the manufacture Turbo Ace does not have a specified TBO or specified periodic maintenance, 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 25-30 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 and the percent battery remaining as indicated on the laptop display.

4.2 Inspection and Maintenance Procedures

UNR AirCTEMPs Tarot 650 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**

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. GoPro for storage and transportation (post mission).

_____ **Batteries**

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

Check batteries for bloating. This in an indication of a failing LiPo battery. If battery shell is bloated, replace as soon as possible and do not continue use.

_____ **Laptop**

Check laptop for current Mission Planner/software updates. Ensure it is current.

_____ **Accessories**

Check flight, controller and laptop 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.

NIAS Pre-Mission Condition Setting E-Checklist

Certificate of Authorization (COA) Missions

UNR AirCTEMPs Mission _____

Airframe Tail # _____

Check all Boxed Items and Fill in all Highlighted Items for EVERY Mission

☐ ND/Master Service Agreement/Teaming Agreement signed by NIAS.

☐ Pilot PIC (400' COA or 200' COA) licensing (FAA private pilot certificate or FAA Sport pilot certificate) and visual observer requirements met. Pilots, supplemental pilots, which are those pilots assigned unmanned aircraft light duties to augment the PIC, and observers must maintain a current third class (or higher) airman medical certificate that has been issued under 14 CFR Part 67, or an FAA accepted agency equivalent based on the application. NIAS needs a photo copy of the actual license.

☐ UAS location is not within the 5, 3, or 2 NM distance to airport with or without a control tower, or a heliport, glider port, or seaplane landing area listed in the Airport Facility Directory.

☐ Aircrew operator's manual – how you train your pilots and manage aircrew and airframe safety – how is maintenance integrated into your safety process?

☐ Maintenance Manual – how do you repair your systems, track parts, and ensure the required scheduled and unscheduled maintenance is performed.

☐ Land permission letter from owner.

☐ *Privacy requirements met: check NV Assembly Bill 239, CA Assembly Bill 2306. OR State House Bill 2710.

☐ Completed Risk Assessment: Signed off by NIAS. NIAS will send you a template and you can modify.

☐ Completed lease document with all signatures.

☐ Completed mission public aircraft declaration.

☐ Copy of insurance certificate: one pager with coverage limits listed – List NIAS as additionally insured. Contact NIAS/UAS Governing Body at the soonest if you don't have any coverage.

☐ Copy of the list of airframes (by VIN and registered through the FAA) and list of aircrews participating in testing/mission execution.

☐ Emailed listing by name and what position each individual will lead on mission day.

☐ CRM and risk management crew refresher test sent by NIAS/ UAS Governing Body and completed by all aircrews participating on mission—satisfies COA SMS requirements.

☐ Copy of PIC designation letter from UAS and a statement that the PIC currency requirements have been met – three takeoff and landings in the same type/series/model N-numbered UAS and current medical have been met. This currency includes a review of aircraft emergency procedures (lost link, inflight malfunction, and recovery of downed aircraft).

☐ Maintenance readiness of your two systems (primary and backup) participating in the flight. Will the scheduled maintenance be complete before the mission day?

☐ NOTAM filed not more than 72 hours in advance but no later than 24 hours out: 1-877-487-6867 (NOTAM Flight Service Station).

☐ Media coverage – No media unless cleared through GOED Director of Communications.

☐ Airworthiness Statement issued by NIAS/UAS Governing Body to UAS Company before the mission day (last conditions setting step).

*NV: A person shall not operate a UAS within 500 feet horizontal distance or a vertical distance of 250 feet from a critical facility without the written consent of the owner. A person who owns or lawfully occupies real property in NV may bring an action for trespass against the owner or operator of an unmanned aerial vehicle that is flown at a height of less than 250 feet over the property.

*CA: Check CA particularly around LA.

*OR: Property Owners have the right to sue for trespassing a drone owner/operator if: 1) the drone has been flow less than 400 a.g.l. over the owner's property at least once, 2) Property owner has communicated to the owner/operator that consent has not been given, and 3) the owner/operator proceeds to fly over the property again.

I. ND/Master Service Agreement/Teaming Agreement

Example

NAIS and the University of Nevada have signed a teaming agreement

II. Pilot PIC (400' COA or 200' COA) licensing (FAA private pilot certificate or FAA Sport pilot certificate) and visual observer certifications

Example

PIC Warren Rapp is an FAA certified commercial pilot certified and current. Backup Pilot Susan Welsh is FAA civilian pilot certified. Observers Tyler, Sladek, Adkins and Gaffney will receive their VO certification prior to the flight testing.

III. UAS location

Example

The proposed flight operations are proposed to take place at the Palomino Valley Turf Farm and/or the Reno Radio Controlled Club (RRCC) flying area in Hungry Valley NV. The Palomino Valley Turf Farm is within 2 NM of several private airstrips. The RRCC facility is 2.4 NM from the Spanish Springs (N86) airport and ~6.2 NM from the Reno-Stead Airport. Neither are towered facilities.

IV. Land permission letter from owner

Example

Permission from the Land Owner will be secured on Monday, November 16, 2015

V. Privacy requirements met

a. The UNR UAS will not operate a UAS within 500 feet horizontal distance or a vertical distance of 250 feet from a critical facility without the written consent of the owner.

VI. Completed Risk Assessment

Example

VII. Completed lease document with all signatures.

Example

If the aircraft and airframe are owned by the University of Nevada, Reno and operated by UNR. No lease agreements are required. Otherwise, a lease agreement is required.

VIII. Completed Mission Public Aircraft declaration

Example

The aircraft is solely owned by the University of Nevada, Reno. The University of Nevada, Reno is a public institution.

IX. Copy of insurance certificate(s)

Example

Insurance is provided by the University of Nevada under its State of Nevada insurance. A copy of the certificate will be provided.

X. List of airframes (and list of aircrews participating in testing/mission execution

Example

DJI Phantom 2
PH646026958
N81NV
Aircrew: W. Rapp, C. Sladek, S. Tyler, R. Gaffney, S. Welsh

XI. Emailed listing by name and what position each individual will lead on mission day

Example

Scott Tyler: Visual Observer
Chris Sladek: Visual Observer and Drone Operator
Rowan Gaffney: Visual Observer
Warren Rapp: PIC
Susan Welsh: Back up Pilot

XII. CRM and risk management crew refresher test sent by NIAS to UAS and completed by all aircrews participating on mission

Example

All crew members have taken the refresher test.

XIII. Copy of PIC designation letter from UNR that the PIC currency requirements have been met – three takeoff and landings in the same type/series/model N-numbered UAS and current medical have been met. This currency includes a review of aircraft emergency procedures (lost link, inflight malfunction, and recovery of downed aircraft)

Example

See Attached PIC designation letter at the end of this document.

XIV. Maintenance readiness of system participating in the flight

Example

The DJI Phantom 2 has been pre-flight checked as per maintenance log and will be prepared for flight on Tuesday November 17, 2015.

XV. Notam filed not more than 72 hours in advance but no later than 24 hours out: 1-877-487-6867 (NOTAM Flight Service Station)

Example

To be filed after NAIS review of documents.

XVI. Media coverage

Example

No media coverage is planned for this activity.

XVII. Airworthiness Statement issued by NIAS to UNR

Example

See attached Airworthiness statement.

COLLEGE OF SCIENCES

UNIVERSITY OF NEVADA •Reno

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November 12, 2015

RE: PIC Designation for AirCTEMPS Mission Scheduled for November 17, 2015

Dear Chris

Warren Rapp, UNR's NAASIC business manager, will serve at Pilot in Command (PIC) for missions scheduled for November 17, 2015. Mr. Rapp has an FAA Commercial Pilot rating. He will serve as PIC for missions flown by N80NV and N81NV. Mr. Rapp is current in both aircraft, having performed multiple landings and takeoffs of these aircraft in Mongolia between September 30 and October 10, 2015. He is current in medical, and has reviewed the emergency procedures for these aircraft as laid out in CTEMPs Aircrew Operators and Maintenance Manual.

Again, thank you for the opportunity to support this outstanding researcher and educator.

Dr. Susan Welsh will serve as backup Pilot; Dr. Welsh will complete her FAA Class 3 Medical examination by November 17, 2015.

Please do not hesitate to contact me at 775-224-3815 or styler@unr.edu if I can provide any additional information.

Best Regards,

Scott W. Tyler
Professor

Nevada Institute for Autonomous Systems
Unmanned Aircraft Systems Program Management Office
400 S. 4th Street, Suite 500
Las Vegas, NV 89101
(702) 793-4219

16 November 2015

SUBJECT: Airworthiness Statement (AWS) for operation of the UNR (Hydrogeology Dept.) DJI Phantom 2 (N81NV) and DJI Phantom 3 (N80NV)

1. Scope: This letter constitutes an AWS authorizing operation of the UNR (Hydrogeology Dept.) DJI Phantom 2 (N81NV) and DJI Phantom 3 (N80NV) UAS for operations at locations authorized under the NIAS/FAA OTA agreement. This AWS is intended to support the issuance of a Certificate of Waiver or Authorization (COA) from the Federal Aviation Administration (FAA). This UAS meets applicable airworthiness standards and requirements of the Nevada Institute for Autonomous Systems (NIAS) as outlined in the NIAS Aviation Safety Inspection, document number PMOUAS-AS-777-FLT-1-6-004, Rev#1 and according to a safety review board conducted the week of 16 November 15.

2. Validity: This AWS is valid for the period of performance outlined in the approved COA. Unless specifically reviewed by the NIAS Director of Technical Operations, this AWS is terminated upon changes in configuration of the subject equipment beyond authorized payload changes, or upon issuance of a later AWS, whichever occurs first. This AWS is valid only for the operations specified within the approved locations authorized under the FAA /NIAS OTA agreement.

3. Point of contact (POC):

Chris Walach
Director of Technical Operations
Nevada Institute for Autonomous Systems (NIAS)
400 S. 4th Street, Suite 500
Las Vegas, Nevada 89101
Work: 702.793.4219
Email: chris.walach@nias-uas.com

Pre-Departure Checklist:
(1-3 Days Prior to Departure)

Procedure

1. Check Charging Checklist. All batteries charged and ready to go?
2. Call **Lockheed Flight Services** to file NOTAM's.
   -Phone number: **(1-877-487-6867)**
   -File at least **3-days** prior to departure
3. Prefetch imagery, mapping data into Mission Planner
4. Check to ensure sectional is loaded in google maps on GCS
5. Establish plot locations, load corners in to GPS or phone
6. Create library in Trimble Pathfinder Office
7. (1 day before): Check NOTAM processing. Confirm Processing
8. Call Seattle center to hours before flight
   -Phone Number: (Insert number here)
9. Contact nearest airport (if within 25 miles of flight) on departure date
10. Double check Equipment Checklist
11. Check functionality of (turn on and make sure operational)
    -Range Finder
    -Laptop
    -Netbook/iPAD/tablet
    -UAS
    -Controller
    -Cameras
    -GPS
11. Test gimbals and perform test flight if UAS has not been flown in last **5 days**.
12. Update Cameras to GPS time
13. Run through field packing lists again
14. Print directions
15. Pack food (if needed) and water

Charging Checklist
(1-2 Days Prior)

Batteries and Electronics

Charged/Charging?	QTY	Battery
○	_____	22,000 mAH 6S
○	_____	1000-2000 mAH 3S
○	_____	GoPro
○	_____	NEX Camera
○	_____	Canon G15
○	_____	RC Transmitter
○	_____	FARO
○	_____	Laptop/Netbook
○	_____	Tablet/iPAD
○	_____	Cell phone(s)
○	_____	Geo Explorer
○	_____	Timble Li. Ion
○	_____	Multispectral

Mission Packing Checklist - Page 1
(Day Prior)

Batteries (1/2 Charged or Charged)

- Matrix (22,000 mAh)

  Qty:_____

- Gimbal

  Qty:_____

- NEX

  Qty:_____

- Canon G15

  Qty:_____

- FARO LIDAR

  Qty:_____

- R8 Li Ion

  Qty:_____

- GoPro

  Qty:_____

- Spare AA/AAA Batteries

  Qty:_____

- Multispectral

  Qty:_____

Charging Equipment

- Power Supply(ies)

  Qty:_____

- Charging Units

  XT60:_____

  XT90:_____

  Balance Port Adpt._____

  Lith. Bat Charger_____

- GoPro USB Charging Cable

  Qty:_____

- GoPro Battery Charger

  Qty:_____

- Generator

  Qty:_____

- Extension Cords

  Qty:_____

- Laptop/Tablet Charging Cable
- iPAD Charging Cable
- Netbook Charging Cable
- Multispectral Battery Charger

Mission Packing Checklist- Page 2
(Day Prior)

Camera Equipment

- ❑ IR GoPro
- ❑ Color GoPro
- ❑ Canon Telephoto
- ❑ Lens cleaning kit
- ❑ Color NEX
- ❑ IR NEX
- ❑ Gimbal Mounting Kit (box)
- ❑ 64 GB Micro SD Cards

  Quantity: _____
- ❑ Micro SD - SD Adaptor Chip
- ❑ 128 GB SD Cards

  Quantity: _____
- ❑ Calibration Targets, White

  Quantity: _____
- ❑ Calibration Targets, Black

  Quantity: _____
- ❑ Gray Card
- ❑ Mounting Screws Box

AIS Lab UAS Ops. Info

- ❑ Preflight checklist
- ❑ CoA
- ❑ Medical Certifications
- ❑ Pilot Certifications

Additional Electronics

- ❑ FARO Scanner Kit
- ❑ iPAD
- ❑ HP Netbook
- ❑ Range Finder
- ❑ External Hard Drive (cords too!)
- ❑ Cell Phone(s)

Tool Kit Supplies

- ❑ Socket Wrench Set
- ❑ Allen Wrench Set
- ❑ Needle-Nose Pliers
- ❑ Hex Driver Set
- ❑ Electrical Tape
- ❑ Packing Tape
- ❑ Duct Tape
- ❑ Extra Velcro straps
- ❑ Zip Ties
- ❑ Rotor Blade wrench (IRIS, Solo)

Field and Safety Gear

- ❑ Backpack (electronics)
- ❑ Backpack (solo)
- ❑ Hardhats

  Quantity: _____
- ❑ Sunscreen
- ❑ Cruising Prism
- ❑ Cruising Vest
- ❑ Rain Gear
- ❑ Jacket
- ❑ Hat/hood
- ❑ Rain Pants
- ❑ Toilet Paper
- ❑ Hand Sanitizer
- ❑ Water Bottle(s)

  Quantity: _____
- ❑ Field boots

  Quantity: _____
- ❑ Sun Hat
- ❑ Fire Extinguisher

  Exp. Date:_____
- ❑ First Aid Kit
- ❑ DBH Tape
- ❑ Tape Measure

Mission Packing Checklist - Page 3
(Day Prior)

Ground Control Gear

- ❑ Bipod
- ❑ Antenna Mast
- ❑ Tornado Antenna
- ❑ R8 Base Antenna/Receiver
- ❑ R8 Rover Antenna/Receiver
- ❑ Trimble GEO XH
- ❑ Antenna Cable
- ❑ Targets
- ❑ Box of staples/stakes
- ❑ Surveying Tripod
- ❑ Rover Bipod
- ❑ Surveying Tape Measure
- ❑ Field Notebook (write-in-the-Rain)
- ❑ Pens, pencils

MATRIX Equipment

- ❑ VHF Radio
- ❑ GCS Laptop
- ❑ 915 Hz Telemetry Radios
- ❑ Spare GPS module
- ❑ Spare 3DR 6 Wire Extension
- ❑ Spare 3DR 5 Wire Extension
- ❑ Matrix Arm Mount. Screws
- ❑ Matrix UAS + Case
- ❑ RC Transmitter
- ❑ GoPro Mounting Bracket
- ❑ Spare Rotor Blades

  Quantity:_____
- ❑ Spare Motors (cw & ccw)

  Quantity:_____

SOLO Equipment

- ❑ UAS Case + Solo
- ❑ Spare Blades

  Quantity:_____
- ❑ Spare Blades

  Quantity:_____
- ❑ Spare Motors (cw & ccw)

  Quantity:_____
- ❑ Hex Tool set
- ❑ Quick Start Guide (Solo and IRIS)
- ❑ Other Manuals

DJI Equipment

- ❑ UAS Case
- ❑ Spare Blades (cw)

  Quantity:_____
- ❑ Spare Blades (ccw)

  Quantity:_____
- ❑ Spare Motors (cw & ccw)

  Quantity:_____
- ❑ Hex Tool set
- ❑ Quick Start Guide
- ❑ Other Manuals

Pre-Mission General Procedure
(Before First Flight)

Steps

1. Assemble (as needed) UAS

    -check any and all screws

    -blades correctly mounted (cs and ccw tightened appropriately)

    -legs, arms correctly mounted

    -Gimble (if needed, correctly mounted and balanced?

    -Velcro for battery system in good condition (Matrix)?

2. Turn on GCS and check
3. Boot up Mission Planner Software, check
4. Plug in Telemetry Radio (if applicable)
5. Conduct Safety Briefing
6. Follow pre-flight instructions

Pre-Flight Safety and Hazardous Scenarios Checklist- Page 1

Safety and Observer Brief: For PIC, CO-Pilot and other observers, workers

1. Review 14 CFR 91.113 (next page, for reference)
2. Establish safe distance from aircraft while it's operational

-20m for non-pilot personnel

-150m for unaffiliated people

1. Establish, if necessary, a barrier between non-flight personnel and the aircraft itself
2. Incident reporting procedures **(clarify this with Jon. FAA procedures, as if an incident occurred in a plane?)**
3. Make sure everyone know where fire extinguisher is, and that everyone can easily access and use it
4. Establish location of first aid kit
5. Anyone within 150m required to wear a hard-hat
6. Phone, radio emergency contact procedures established.
7. Discuss pilot-observer distractions. When is it appropriate to talk to PIC, co-pilot? Etc…

Hazardous Situation Response Procedures

1. <u>TX Communications lost</u>
    i. If loitering, then reduce physical distance until control regained
    ii. if in RTL, stand a safe distance from landing location, attempt to regain control
2. <u>Telemetry Communications lost</u>
    i. If loitering, then reduce physical distance until control regained
    ii. if in RTL, stand a safe distance from landing location, attempt to regain control
3. <u>Bird in Vicinity: circling craft</u>
    i. If within **10m** of aircraft: FOR MATRIX

    -Climb to max ceiling (400ft) to test whether bird will lose interest in craft

    -IF NO: bring aircraft to home position and land.

    ii. If within **10m** of aircraft: FOR SOLO

    -Geofence will not allow craft to fly higher than 100m (330ft), therefore:

    -bring craft to home position and land

Pre-Flight Safety and Hazardous Scenarios Checklist- Page 2

4. Sudden Loss of Altitude or Crash
    i. Steer aircraft away from any and all personnel and bystanders
    ii. Communicate situation concisely and quickly to all bystanders
    iii. Reduce throttle/slow descent as much as is possible
    iv. If Possible, not last geo position on your GCS
    v. Find and obtain fire extinguisher
    vi. Recover craft. Follow shut-down procedures if craft is still powered on

Right-of-way rules: Except Water Operations

*§ 91.113 Right-of-way rules: Except water operations.**(a) Inapplicability.** This section does not apply to the operation of an aircraft on water.*

***(b) General.** When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules or visual flight rules, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft. When a rule of this section gives another aircraft the right-of-way, the pilot shall give way to that aircraft and may not pass over, under, or ahead of it unless well clear.*

***(c) In distress.** An aircraft in distress has the right-of-way over all other air traffic.*

***(d) Converging.** When aircraft of the same category are converging at approximately the same altitude (except head-on, or nearly so), the aircraft to the other's right has the right-of-way. If the aircraft are of different categories—*

***(1)** A balloon has the right-of-way over any other category of aircraft;*

***(2)** A glider has the right-of-way over an airship, powered parachute, weight-shift-control aircraft, airplane, or rotorcraft.*

***(3)** An airship has the right-of-way over a powered parachute, weight-shift-control aircraft, airplane, or rotorcraft.*

However, an aircraft towing or refueling other aircraft has the right-of-way over all other engine-driven aircraft.

***(e) Approaching head-on.** When aircraft are approaching each other head-on, or nearly so, each pilot of each aircraft shall alter course to the right.*

***(f) Overtaking.** Each aircraft that is being overtaken has the right-of-way and each pilot of an overtaking aircraft shall alter course to the right to pass well clear.*

***(g) Landing.** Aircraft, while on final approach to land or while landing, have the right-of-way over other aircraft in flight or operating on the surface, except that they shall not take advantage of this rule to force an aircraft off the runway surface which has already landed and is attempting to make way for an aircraft on final approach. When two or more aircraft are approaching an airport for the purpose of landing, the aircraft at the lower altitude has the right-of-way, but it shall not take advantage of this rule to cut in front of another which is on final approach to land or to overtake that aircraft.*

[Doc. No. 18334, 54 FR 34294, Aug. 18, 1989, as amended by Amdt. 91-282, 69 FR 44880, July 27, 2004]

Summary Flight Procedure: Matrix

UAS

1. Turn on RC Transmitter
2. Ensure proper UAS model is selected
3. TX switches forward (if applicable)
4. TX throttle down
5. Plug in battery to UAS
6. Check roll, pitch, yaw response to movement on Mission Planner
7. Check mode change switch if applicable (loiter, stabilize, auto, etc..)

Camera

9. Install battery in Camera
10. Install SD card in Camera
11. Turn on Camera
12. Photograph GPS time on Mission Planner display
13. Set manual focus against target to >40m
14. Set white balance with the gray card
15. Check Battery Level
16. Check SD card Capacity
17. Mount Camera on Gimbal
18. Clean lens

Gimbal

19. Check Gimbal Balance; check for neutral
20. Plug in Gimbal Battery (if applicable) WAIT 10 seconds

Video

21. Turn on real time feed monitor
22. Plug in video TX and RX
23. Test video Signal
24. Change camera to intervalometer mode
25. Check home position for UAS on Mission Planner.
26. Upload or set up Mission (though this should be done before this point!)
27. Check Mission has upload correctly.
28. Monitor GPS lock until **PDOP is <2.0 meters**

Pre Takeoff

29. Check area for flight hazards, low flying aircraft
30. Ensure personnel are clear of takeoff area and flight path

On the UAS

31. Put UAS in 'loiter mode'
32. Push Pre-Arm button (Matrix, IRIS, Solo)
33. Arm the autopilot from the Transmitter
34. Take off
35. Rise to Mission altitude
36. Switch to 'auto' mode

Summary Flight Procedure: Gwaihir- Page 1

Initial set up

1. Mount batteries
2. Check that the CG is centered, or *very slightly* shifted toward nose (nose-heavy)

Batteries

3. Install "screamers" on batteries
4. Install GoPro Cameras
5. Plug IMU into computer (white USB connector)
6. Plug Lidar into computer (black Ethernet connector)
7. Check: USB drive plugged into **upper right** USB slot
8. TX switches forward
9. TX throttle all the way down
10. TX aileron centered
11. Turn on **transmitter (NOT craft!)**
12. Check model: TX is "Heavy Lift Helicopter"
13. Throttle hold 'on' ("SG switch should be **up, toward you)**

Power plug in Sequence

14. Ensure throttle hold is **on**
15. Top right battery (1) to plug into input with flight controller power lead (1)
16. WAIT TEN SECONDS for IMU gyros to stabilize
17. Top left battery (2) into input at bottom left *Listen for arming tone from ESC*
18. WAIT ANOTHER TEN SECONDS for IMU gyros
19. **Arming tone should produce 12 tones, corresponding to a 12 cell battery**
20. *Unusual tone: ESC log is full. Download and start over*
21. Connect final two batteries.

Transmitter input check

22. Check throttle hold is **on**
23. Right stick (elevator) forward: check that swash tilts forward
24. Right stick (elevator backward: check that swash tilts backward
25. Right stick to right (aileron): check that swash tilts right
26. Left stick to right (aileron): check that swash tilts left
27. Again **check that throttle hold is on**
28. Left stick (throttle/pitch) up: check that swash plate move **up** shaft
29. Return left stick to lowest position
30. Left stick (yaw) left: check that tail blades are blowing air to **left side** of aircraft
31. Left stick (yaw) right: check that tail blades are blowing air to **right side** of aircraft

Gyro Check

32. Check that throttle hold is still **on**
33. Tilt nose down: swash should tilt **back** to compensate
34. Tilt nose up: swash should tilt **forward** to compensate
35. Tilt craft left: swash should tilt **right**
36. Tilt craft right: swash should tilt **left**
37. Pull craft toward you: air should *hypothetically* blow toward you to oppose the pull
38. Push away from you: air should *hypothetically* blow away from you to oppose push

Auto Pilot Check

39. Throttle **down** and throttle hold still **on**
40. Start with switch fully forward
41. Full forward to GPS: two green lights should be flashing on GPS antenna
42. Switch to center position: two purple flashes should be seen on GPS antenna
43. Switch to full manual mode: no lights should be flashing on the GPS antenna
44. Return to full forward (GPS mode): 2 green flashing lights again

Summary Flight Procedure: Gwaihir- Page 2

45. IMPORTANT: if lights flash **red**. This is a NO GO for flight
46. All switches forward EXCEPT THROTTLE HOLD
47. Throttle position still fully back
48. Toggle switch F (rate mode switch) from forward to back, then to forward again

-*this centers the tail rotor for takeoff position*

Payload Start up

49. Turn on Cameras
50. Plug in payload battery: check to make sure Lidar is spinning
51. Throttle hold forward. Throttle hold **off.**
52. Increase throttle/pitch to 2nd position ind. Bar

-*this initiates ESC governor; ramps up RPM to operating speed*

53. Wait for ESC to spool up to RPM

Take off

54. Increase throttle/pitch to stick just above 5th position
55. Climb to altitude. Reduce throttle to just below 4th position to **hover**

Ground station transfer

56. Click '**go**' on pre-planned mission
57. Toggle Mode Switch (TSE) forward and back to set to GPS cruise

Landing

58. Return to hover in GPS mode over landing location
59. Decrease throttle to just below 4th position to initiate **slow** descent

NEVER LOWER BELOW 3RD POSITION DURING LANDING

When skids touch ground

60. Lower throttle to 3rd indicator position
61. Switch throttle hold indicator backward (hold **on**)
62. Look for (red-blue-flash white) GPS light indicator
63. WAIT 8-10 seconds for throttle to turn off
64. Put throttle position at its lowest indicator position

OSU: Field Work Safety Planning Record

Pursuant to the Oregon State University's Fieldwork Safety Instruction, this form, is to be completed by the Principal Investigator and submitted to the Department Chair (or equivalent) prior to the departure on research travel and fieldwork. Numerous excursions to the same location or group of locations can be dealt with via one form. The form is good for a single academic year and a new form must be completed annually.

Department: _____ Principal investigator: _____
Location of Fieldwork:
Country / State: _____
Geographical Site: _____
Nearest City (name, distance to): _____
Nature of Research: _____

Date of Departure: _____ Date of Return: _____

Fieldwork Team:
(Please identify team leader(s))

Name	Category			
	Employee	Student	Volunteer	First Aid Trained

Hazard Identification –
Identification of the hazards is critical to ensuring the safety of the Fieldwork Team. The following checklist will provide a guide to identifying common hazards, however, the Principal Investigator should review all aspects of the fieldwork to ensure comprehensive hazard identification has been completed.

Physical Demands –
What physical demands will the fieldwork entail?

- ☐ Climbing
- ☐ High Altitude
- ☐ Hiking
- ☐ Extreme Heat
- ☐ Extreme Cold
- ☐ Sun Exposure
- ☐ Manual lifting, carrying or handling heavy loads
- ☐ Working on, near, or over water
- ☐ Other:_____

Orientation:

Yes	No	N/A	
			Have arrangements been made to provide participants with: ☐ Potable water ☐ Personal washing/hygiene ☐ Toilet facilities or procedures
			Are participants aware of suitable clothing, footwear and personal supplies required (e.g. boots, hat, raingear, sunglasses, sunscreen, insect repellent)? List required personal supplies and attach to form.
			Have arrangements been made to provide participants with, and train them in the safe use of, appropriate personal protective equipment such as: ☐ Safety Glasses ☐ Respiratory Protection ☐ Coveralls ☐ Protective Footwear ☐ Protective Headwear ☐ Hearing Protection ☐ Gloves ☐ Face Shield ☐ Waders (Hip, Chest) ☐ Knee/shin Guards ☐ Flame Retardant Clothing ☐ Other:
			Are participants familiar with Oregon State University's policy on the use of alcohol and drugs?
			Are participants familiar with Oregon State University's policies such as, Health and Safety Policy / Respectful Workplace and Learning Environment Policy / Violence Prevention Policy?

Other Hazards/Protective Measures/Comments: _____

Working Alone
(see Oregon State University's Working Alone Instruction)

Yes	No	N/A	
			Will any participant be working alone? (See Working Alone Safety Instruction):
			Has an effective communications system been established (e.g. radio, walkie-talkies, phones, whistles, air horns, flares, frequent and scheduled contact)? Describe system:

What other means can be employed to reduce the risk to a participant when working alone?

Yes	No	N/A	
			Limitations or prohibitions on certain activities while alone
			Provision of emergency supplies
			Establishment of minimum training or experience or other standards of competency before working alone
			Other:

Other Hazards/Protective Measures/Comments: _____

_____
_____
_____
_____
_____

Remote Areas:

What communication systems will be employed?

☐ Cell Phones	☐ Leaving Itinerary at Base Camp	☐ Whistles/Air Horns
☐ Radio or Walkie-Talkies	☐ Scheduled contacts	☐ Satellite phone
☐ Other: _____		

How will participants remain orientated to their location?

☐ Maps	☐ Compass	☐ Identification of safest routes
☐ GPS (spare batteries)	☐ Local guides	☐ Area familiarization trips
☐ Arial photo	☐ Other: _____	

What procedures have been established in the case participant(s) become lost?

☐ Participant training on remaining at location, use of emergency signals, use of emergency survival gear
☐ Provision of survival gear
☐ Procedure for organized search
☐ Precautions against fire
☐ Precautions in the event of extreme weather conditions
☐ Other Hazards/Protective Measures/Comments: _____

_____
_____
_____
_____

Wildlife:

Yes	No	N/A	
			Have participants been adequately trained in the handling, capture and restraint of study species?
			Will participants be administering drugs/anaesthetics or obtaining biological samples? If so, have they been trained in techniques appropriate to the species and in how to manage disposal of waste or surplus materials?
			Have participants been instructed on techniques to avoid unexpected encounters with potentially dangerous wildlife?
			Are participants familiar with the methods of contraction of disease from wildlife in the area?
			Have participants been made aware of the signs/ symptoms of potential zoonoses that may be present in wildlife in the study area?
			Have participants been made aware of potential vegetation hazards and the identification of toxic plants such as Poison Oak / Poison Ivy?

Other Hazards/Protective Measures/Comments: _____

Chemicals and Hazardous Materials:

Yes	No	N/A	
			Is each hazardous properly identified with a supplier or label?
			Will hazardous material be transported to and from the site?
			Will Material Safety Data Sheets for each hazardous material used be readily available to participants?
			Will samples be collected, preserved in hazardous material (ethanol, formalin)?
			Will appropriate materials be available to adequately handle hazardous materials, spills, leaks or releases? Describe materials and attach to form.
			Will radioisotopes be transported or used in the field? If so, have participants been trained to safely use, store and transport the material in accordance with legal requirements and licence conditions? (see Radiation Safety Policy)

Other Hazards/Protective Measures/Comments: _____

Safe Use of Equipment and Work Processes:

Some equipment and activities to which specific training or certification is required include:

- ☐ Chain Saws
- ☐ Compressed Gases
- ☐ Confined Space
- ☐ Diving (Free, SCUBA, Line, NITROX, Tri Gas)
- ☐ Excavation/Trenching/Tunnelling
- ☐ Noise exposure above 85dBA$_{lex}$
- ☐ Powered saws, grinders & planers
- ☐ Firearms
- ☐ Fire Extinguisher
- ☐ Explosives
- ☐ Fall Protection above 6 feet
- ☐ Hazardous Materials
- ☐ Ladders
- ☐ Lifting Devices and Hoists
- ☐ Scaffolds
- ☐ Travel Un-Improved Roads
- ☐ ATV, PWC, other Water Craft
- ☐ Climbing, Rappelling, Rope work
- ☐ Powered Mobile Equipment (fork lift, tractor, heavy equipment)
- ☐ Minimum Distances from exposed energized conductors (e.g. power lines)

Yes	No	N/A	
			Are participants trained to operate the equipment safely and in compliance with regulatory standards?
			Have employees been trained in safe work procedures?

List Powered or Hazardous Equipment:

_____

_____

List Hazardous Procedures:

_____

_____

REQUIREMENTS

Equipment

All equipment to be taken on a field trip must be checked by a qualified person to ensure that it is in good condition, complete and safe (before removal from the campus). Documentation of this pre-trip assessment of the equipment is advised. Individuals operating the equipment must be trained in the proper use of the equipment.

Clothing

Fieldwork participants should be informed of the appropriate clothing to be worn while conducting their work. The appropriate clothing may have to be provided by the University or the worker may have to provide his or her own clothing, depending on requirements.

It should be identified whether or not there is special protective gear to be used while conducting the particular fieldwork and where necessary, this protective clothing must be used and the appropriate training provided in the proper use and maintenance of the personal protective equipment.

When extreme weather conditions can be anticipated or are known, clothing appropriate to the situation should be taken on the fieldwork excursion.

Fieldwork participants must employ common sense in terms of clothing worn on the fieldwork excursion. Participants inappropriately attired or without the correct PPE will not be allowed to participate in the Fieldwork.

First-Aid Kits

First-aid kits are required for all off-campus operations. It is the responsibility of the Primary Investigator to provide and ensure that the kit is maintained. Prior to the departure for fieldwork the Primary Investigator is responsible to document the presence of a first-aid kit for the trip and any other required first-aid supplies. Refer to OSU Safety Instruction #6 http://oregonstate.edu/ehs/bulletin/si06.html
For First Aid Requirements as required by The Occupational Health and Safety Regulations.

Immunizations, Emergency Preparedness and First Aid

Travel Immunization/Prophylaxis Requirements:
http://www.cdc.gov/vaccines/recs/acip/default.htm

☐	Diphtheria	☐	Polio	☐	Other (specify below):
☐	Hepatitis A	☐	Rabies		_____
☐	Hepatitis B	☐	Rubella		_____
☐	Japanese Encephalitis	☐	Tetanus		_____
☐	Malaria	☐	Typhoid		_____
☐	Measles	☐	Yellow Fever		_____

Yes	No	N/A	
			Has itinerary been left with responsible person at the University?
			Will itinerary be left with responsible local authority?
			Are emergency contact numbers for local emergency assistance known?
			Are emergency contact numbers for each participant known? Attach list or describe location of list:

Yes	No	N/A	
			Are Student Health or Primary Health Insurance Numbers (or equivalent) for each participant available? Attach list or describe location of list:
			Is first aid kit complete?
			Are all participants familiar with the location of first aid kit and its contents?
			Has nearest medical facility been identified? Include Name, Location, & Distance from fieldwork site:
			Is a first aid attendant required? Name(s) of attendant(s):
			Are additional first aid supplies required? List:
			Is there means to summon assistance in case of emergency? Describe:
			Are participants familiar with the Oregon State University Incident Reporting Process? (See website http://oregonstate.edu/admin/hr/benefits/roa.pdf)

Other Hazards/Protective Measures/Comments: _____

EMERGENCY PROCEDURES

Emergency Plan for Research Location: include information on communication, equipment; local emergency contacts, emergency OSU contacts, etc. (**attach copy to form**)

University Contact and Phone #	Local Contact and Phone #
1.	1.
2.	2.
3.	3.
4.	4.

Equipment Checklist:

- ☐ Specialized Clothing – describe: _____
- ☐ PPE (respirator, eye/face protection/head protection/footwear/high visibility wear) - describe: _____
- ☐ Training on safe use procedures for power equipment
- ☐ Other training
- ☐ Communication devices (e.g. whistles, 2-way radios)
- ☐ First Aid kit
- ☐ First Aid attendant (see Appendix 12)
- ☐ Licenses (e.g. vehicle/boat/diving equipment)
- ☐ Other: _____
- ☐ Additional First Aid or medical supplies
- ☐ Emergency supplies
- ☐ Vehicle travel survival kit
- ☐ Material Safety Data Sheets
- ☐ Maps

RISK ASSESSMENT:
List identified hazards related to activities or environment (i.e. extreme heat or cold, wild animals, endemic disease, firearms, explosives, violence), and chosen available measures for eliminating or reducing risks to acceptable levels:

RISK	PRECAUTIONS TO BE IMPLEMENTED
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Notes:

I, the undersigned, acknowledge that, in keeping with the Oregon State University's Fieldwork Safety Instruction:

(a) I have been fully informed of the risks of this fieldwork and that I accept them;
(b) I am aware of and will comply with the established safety procedures and my duties as a participant as set out in the OSU's Travel and Fieldwork Safety Instruction, including my duty to take reasonable care for my health and safety and the health and safety of others who may be affected by my actions;
(c) I am in a satisfactory state of health to undertake the research;

(d) I have received all of the recommended immunizations;
(e) I am aware of limitations of insurance coverage; and
(f) I am aware that I may be subject to academic discipline should I fail to comply with the Fieldwork Safety Instruction and established safety procedures.
(g) For specific requirements reference the Oregon State University Fieldwork Safety Instruction for referenced Safety Instructions, Training requirements, and guidelines.

ACKNOWLEDGMENT OF PARTICIPANTS:		
NAME (print)	SIGNATURE	DATE
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Signature of Principal Investigator
I acknowledge that this safety plan has been prepared in keeping with the requirements of the Oregon State University procedures for safety in fieldwork:

_____

Name (print) Signature Date

Signature of Unit Head (or equivalent)
I acknowledge receipt of this document:

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Name (print) Signature Date

Useful Web Links

CTEMPs Web Link

AirCTEMPs
http://ctemps.org/air-ctemps

General Safety

Safely Flying Drones (general knowledge)
http://knowbeforeyoufly.org/

Manufacturer Links

- DJI
  - Phantom 2 Documents
    - Phantom 2 Quick Start Guide
    - Phantom 2 Flying Flowchart v1.0
    - Phantom 2 Advanced User's Manual v1.4
    - Phantom 2 Smart Flight Battery Safety Guidelines
    - Phantom 2 Ground Station Wireless Data-Link User Manual v3.0
  - Phantom 3 Documents
    - Phantom 3 Quick Start Guide v1.2
    - Phantom 3 Advanced User's Manual v1.6
    - Phantom 3 Intelligent Flight Battery Safety Guidelines
    - Phantom 3 Safety Guidelines and Disclosure

- 3DR SOLO
  - 3DR SOLO User Manual
  - Drone Safety

- Turbo-Ace MATRIX
  - Turbo-Ace MATRIX User Manual

- NAZA-M LITE GPS Documents
  - User Manual v2.0
  - Quick Start Guide v1.0
  - NAZA wiki: Transmitter Calibration
- FRSKY RECEIVERS
  - X8R Manual
  - X9D Manual
- ARDUPILOT LINKS
  - Tone Status Information
  - Compass Set up and Calibration

- SEAGULL MANUALS AND PROCESSES
    - Camera Trigger Steps
    - Camera Trigger Manual

Regulatory Agencies

Federal Aviation Administration Updates on Regulations
https://www.faa.gov/regulations_policies/

National Conference of State Legislatures – UAS Laws
http://www.ncsl.org/research/transportation/current-unmanned-aircraft-state-law-landscape.aspx

Oregon State House Bill 2534
https://olis.leg.state.or.us/liz/2015R1/Measures/Overview/HB2534

NELIS Link to Nevada Assembly Bill 239
https://www.leg.state.nv.us/Session/78th2015/Reports/history.cfm?ID=520

NIAS: Nevada Institute for Autonomous Systems
http://www.nias-uas.com/

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