Cryowing Observer

Pilot Operating Handbook

Registration number:

DOCUMENT CHANGE RECORD			
10.04.2017	WJR	V1.0	First complete draft

Performance and specifications

Speeds and weights summary	
Cruise speed:	TBD
Stall speed:	TBD
Flaps up and power off	TBD
Half flaps and power off	TBD
Full flaps and power off	TBD
Max weight:	TBD
Max useful load:	TBD

General

This POH is a work in progress and some of the performance and specifications are subject to change. Speeds and weights are on the safe side and will progress into limitations. Alteration and entries are to be logged in the change log.

Three view

WIP

Introduction

This section contains general information, abbreviations and terminology explanations

Descriptive data

Engine

Number of engines:	1
Engine manufacturer:	Dualsky
Engine model:	XM4255EA-4.5
Engine type:	Brushless, Kv 790RPM/V
Power rating:	Peak 1128W

Propeller

Fixed propeller	
Number of blades:	Two
Size	TBD after testing

Control surfaces

This aircraft is equipped with 6 MKS DS6100 servos, one for each control surface.

Fuel/Oil

In this document the word tank refers to the battery and the word fuel refers to electrical power.
Fuel: Lithium Polymer batteries.
Minimum battery ampere hours: TBD
Cell count: 4 (16.8v max , charged)
Minimum voltage during flight 14v (3,5v/cell land within 1 min)
Minimum allowed cell voltage: 3.3 V (Critical voltage)

Weights

Standard empty weight:	TBD
MTOW:	TBD
Useful load:	TBD

Specific loading:

Wing loading: TBD

Power loading: TB

Payload space dimensions

TBD

Symbols, abbreviations and terminology

NA: Not Applicable
TBD: To be decided
WIP: Work in progress

Speeds

IAS:
Indicated airspeed. Airspeed from the pitot-static.

CAS:
Calibrated airspeed. Correcting IAS for position error and instrument error.

TAS:

True airspeed. Correcting CAS for temperature and pressure.

V_{fe}: Maximum flap extended speed. Maximum speed with flaps in specified positions

V_{no}: Maximum structural cruising speed. Max speed for normal operations in clean air.

V_{ne}: Never exceed speed. Do not exceed this speed under any circumstance

V_s: Stall speed. The lowest speed at which the aircraft is stable and controllable

V_{so}: Stall speed in landing configuration

V_x: best angle-of-climb speed. The speed that leads to most altitude gain/distance traveled

V_y: best rate-of-ascent speed. The speed that leads to most altitude gain/time

VSI: vertical speed indicator. Indicates altitude gained or lost a minute

Meteorological terminology

OAT: Outside Air Temperature is the free air static temperature. It is expressed In either degrees Celsius.

Standard temperature: Standard Temperature is 15° C at sea level pressure alti-tude and decreases by 2°C for each 1000 leet of altitude.

Pressure Altitude: Pressure Altitude is the altitude red from an altimeter when the altimeter's barometric scale has been set to 29.92 inches of mercury (1013 mb).

Airplane performance and flight planning terminology

KV: motor velocity constant in RPM/volt. RPM of an unloaded motor at one volt.

Usable fuel: Amount of fuel usable to the engine and the amount used in flight planning

Unusable fuel: Fuel amount that can not be safely used

Weight and balance terminology

Reference datum: an imaginary vertical plane from which distances are measured for balancing purposes

CG: center of gravity. The aircraft would be in equilibrium if suspended from that point. Measured for the reference datum

Standard empty weight: weight without usable fuel, batteries or payload and with oil and coolant if applicable. In case of electrically powered aircraft also without any main batteries

Useful load: load available for fuel and payload

MTOW: maximum takeoff weight

Limitations

Introduction

Airspeed limitations

		CAS	IAS	remarks
V_{ne}	Never exceed speed			
V_{no}	Maximum cruising speed			
V_a	Maneuvering speed			
V_{fe}	Maximum flap extended speed			
$VSI\text{-}_{max}$	Maximum vertical speed			

Airspeed markings

No visible markers on airspeed indicator

Power plant limitations

Maximum 1128 Watt for 15 seconds
RPM: Unknown
ESC: 60 Amperes continuous
Motor change with motor with the same or better characteristics is approved.

Propeller limitations

Propeller maximum RPM: TBD 145000/Diameter in inches
Propeller change with propeller with the same characteristics is approved

Power plant instruments markings

No markings are present
Battery voltage is shown in Mission Planner
Current from the battery is shown in Mission Planner
Amp hours used is shown in Mission Planner

Control surfaces limitatioins

Servo change with equal or similar performance is approved. Aileron and flap servos must be equal and changed in pairs if changing to any other than MKS DS6100.

Weight limitations

MTOW: TBD
Useful load: TBD

Center of gravity

X mm from leading edge

Maneuver limits

This aircraft is not certified, but is assumed to be in the normal category.

No aerobatic maneuvers are including spins are not approved.

Flight load factor limits

Unknown

Kinds of operation limits

This aircraft will be setup and approved for RC controll only. **An update of this POH will follow when aircraft is setup with autopilot.**

The aircraft has no icing warning or de icing systems and flying in known icing conditions is prohibited.

Other limitations

Battery limitations:

At low temperatures the capacity of batteries drop. Preheat batteries to room temperature before flying in low temperatures.

Assume that you cannot use the full rated capacity of a battery and that the aircraft has a significant unusable fuel amount.

Cell voltage should not drop below:
Normal use: 3.5V
Assume battery damage below 3.3V

Take off flap range: 0 deg to 10 deg
Landing flap range: 0 deg to full.

Placards

NA

Emergency procedures

Introduction

Section 4 provides checklists and procedures for emergencies.

Airspeeds for emergency operations

Speed for best glide: TBD

Operational checklists

Engine Failures

See forced landings

Forced Landings

Forced auto landing (ABC)

1.	Airspeed	set desired speed to speed for best glide
2.	Best field	select
3.	Checklist:	
4.	Notify	parties it may concern
5.	After touchdown	

Forced manual landing (ABC)

1.	Airspeed	set desired speed to speed for best glide
2.	Best field	select
3.	Checklist:	
4.	Notify	parties it may concern
5.	After touchdown	throttle to idle

Fires

Airplane is not equipped with fire detection systems so fire is hard to detect

Electrical fire

1.	Payload	Shut down
2.	Position	Monitor for latest known point

Engine fire

1.	Engine	Kill
2.	Speed	Max speed
3.	Position	Monitor for latest known point

Electrical power supply systems malfunctions

Payload electrical malfunction

1. Identify source
2. Shut down source of malfunction

If the aircraft is still controllable, ditch the aircraft in safe location or land as soon as possible.
Do not overfly people or populated areas.

Flight in icing conditions

This aircraft is not approved for flight into known icing.

Spins

Spins are not allowed

Rough engine operation or loss of power

4.8.1 Assumed battery failure

1.	Airspeed	set desired speed to speed for best glide
2.	Best field	select
3.	Checklist:	
4.	Notify	parties it may concern
5.	Gear	down
6.	After touchdown	throttle to idle
7.	arm/disarm	disarm

5 Normal procedures

5.1 Introduction

5.2 Checklists

Before going out. General checks

1. Read NOTAMs and issue if applicable
2. Weigh the aircraft.
3. Balance aircraft
4. Check that all batteries are fully charged.
   Onboard battery.
   RC transmitter battery.
   Payload batteries (cameras etc)
5. Load right flightplan/waypoint list to autopilot
6. Download map data to Missionplanner.exe

Preparations on take off site

1. Unload the UAVsystem
2. Arrange Ground Control Area
3. Place GCS antenna in correct position
4. Start Ground control application MissionPlanner

Fuselage mounting

1. Update logbook
2. Mount onboard batteries in wing
3. Mount wings. **Do not power system**
4. Mount tail boom. Secure bolt with tape.
5. Mount tail surface.
6. Check center of gravity
7. Secure wing connectors with tape

Vehicle daily inspection and setup

1. Check for loose objects in avionics bay
2. Engines and propellers (check for loose engine bolts and damaged propellers)
3. Check fuselage
   Windows clean and unscratched?
   Wing section,
   Elevator
   Verify tail boom locking screw fastened
4. Verify antennas in correct positions
5. Power RC control, ensure manual mode (must be on during initialization of AP)
6. Connect onboard battery, notify Ground Control
7. Connect to UAV with Mission Planner
8. Verify waypoint list/fly file
9. Verify GPS 3D fix
10. Check airspeed indication (press finger/hand on pitot)
11. Arm autopilot
12. Verify control surfaces in normal positions
13. Ensure propellers are clear
14. Check RC control of actuators. (Aileron, Elevator, Throttle)
15. Arm motors
16. Advance throttle to 100% to ensure motor output is synced
17. Disarm motors
18. Switch to Stabilize mode
19. Verify control surfaces in normal positions
20. Rotate vehicle about pitch and roll axis. Check for opposing rudder movements.

21. Switch to manual mode
22. Start payload. Check Cam trigger and feedback.
23. Update log with battery voltage
24. Attach canopy

Take- off

1. Verify manual mode
2. Check acceptable wind conditions and runway clear
3. Verify clearance with tower
4. Deploy flaps to takeoff position up to 10 degrees
5. Arm launch mechanism
6. Arm motors
7. Advance throttle to 100%
8. Ready for takeoff to RCpilot
9. Launch at RCpilot's command
10. GCS pilot update log with time of launch

Landing

1. Ensure RC pilot is ready and RC radio is powered
2. Handover GCS pilot to RC pilot
3. RC pilot initiate standard landing pattern
4. Before starting final approach check that runway is clear
5. On final approach deploy flaps to landing position, monitor glide path
6. Kill engine and slowly retract flap before touch down

After landing on site

1. Update log with landing time.
2. Update log with battery voltage
3. Disarm Autopilot
4. Notify tower when landed
5. Disconnect battery
6. Stop payload
7. Update flight log
8. All PICs sign log

Checklists

6 Performance

6.1 Introduction

The performance section is not completely determined. All figures given are on the safe side. **However, always operate with sufficient margin.**

6.2 Speeds for normal operation

Minimum speed in autonomous mode:	TBD m/s
Cruise Normal:	TBD m/s
Max speed in autonomous mode:	TBD m/s

6.Stall speeds

Flaps up and power off:	TBD
Half flaps and power off:	TBD
Full flaps and power off:	TBD

Take off distance

Take off distance is defined as: from start of launch to cleared 15m (50') off the ground.

Take off distance minimum weight, wind calm:	TBD
Take off distance max weight, wind calm:	TBD

Rate of climb

Rate of climb in auto mode	TBD
Rate of climb in manual mode	TBD

Cruise performance

Range:	TBD
Vertical:	TBD
Endurance:	TBD

Landing distance

Landing distance is defined as distance from 50’ above threshold and to a full stop

Landing distance grass	TBD
Landing distance snow	TBD
Landing distance ice	TBD

Weight & balance/equipment list

Introduction

Airplane weighing procedures

The weight of the complete aircraft is easiest measured when fully assemble. In the lab we have equipment to measure the weight and balance simultaneously.

Weight and balance

The aircraft payload can be arbitrary distributed in the payload compartment, as long as the total mass do not exceed the limitations given in section 3.6 Weight limitations, and the C.G is correct

Center of Gravity measured from leading edge of center wing.

Equipment list

TBD

Aircraft & systems description

Introduction

This section provide a brief description of the aircraft and system. This section is not the complete technical documentation of the system. Personnel signed out for operation of the Cryowing Observer is expected to have knowledge surpassing what is found in this section.

Airframe

This aircraft is manufactured by Zeta Science and called “Sky Observer”. Norut will operate this under the name Cryowing Observer. Norut acquires the basic airframe and then equips and

builds it to make it into a Cryowing platform. The Observer is intended to replace the earlier Cryowing Micro. The Observer platform will be considerably cheaper and easier to operate than the CW Scout and therefore it may be possible to fly in places which the CW Scout can not do due to operational risks.

The basic airframe is built up using white styrofoam with wood frames and spars, or carbon fiber tubes, in strategical places to enhance structural integrity. The aircraft is a basic single engine cantilever wing and conventional tail design with a pod suspended beneath the wing with a clear plastic dome both front and rear. The main pod will be the main location for placing any payload as well as main battery(eis). A Pixhawk Autopilot will be installed at a later stage.

One brushless electric motor and one speed controller is mounted in the boom. The ESC also has a BEC circuit which provides 5V to power other flight control systems. There is no redundant power supply.

Flight control system

The Observer has six control surfaces. Two ailerons, two flaps, one elevator and one rudder. All surfaces are “live” hinged in the styrofoam material. These hinges should be inspected thoroughly before each flight as these are prone to damage after some usage.

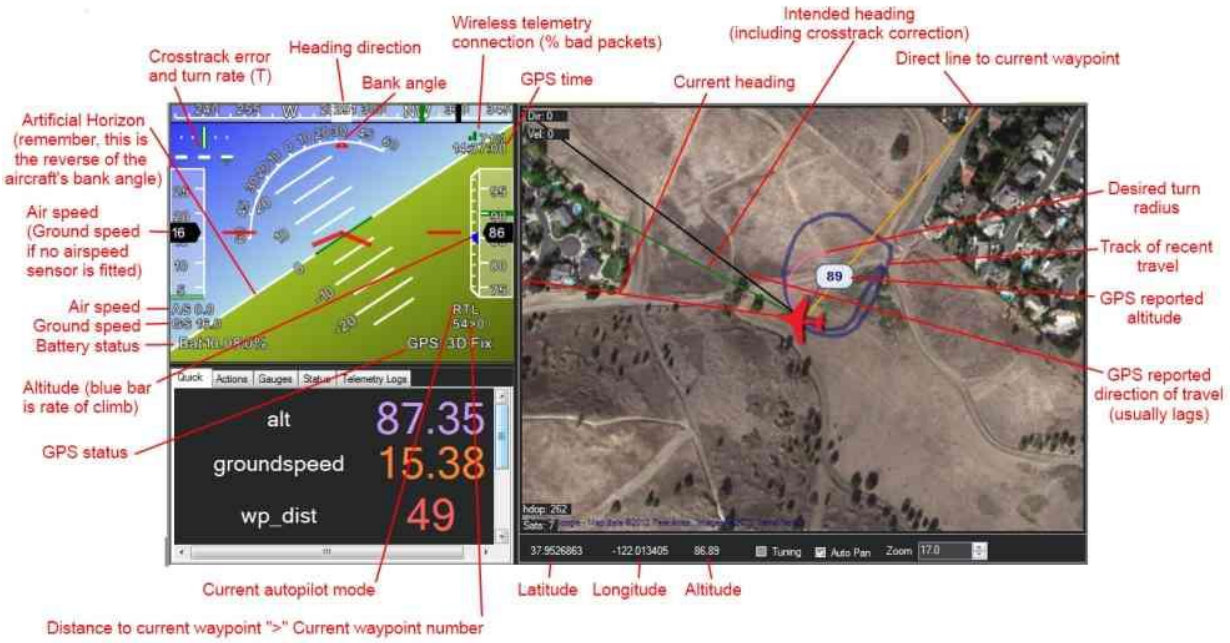
All the flight control surfaces will be operated by one MKS DS6100 servos. This is a high quality precision servo with metal gearset. Between the servo and the control horn there is a metal linkage.

The Autopilot of the Scout is a Pixhawk or equivalent hardware running the Arduplane software. It has a built in AHRS (3-axis attitude, accelerometer and magnetometers) and utilize a GNSS receiver of type Ublox LEA-6 (or better).
Documentation for Arduplane can be found here: http://ardupilot.org/plane/index.html
Documentation for the Pixhawk hardeare can be found here: https://pixhawk.org/

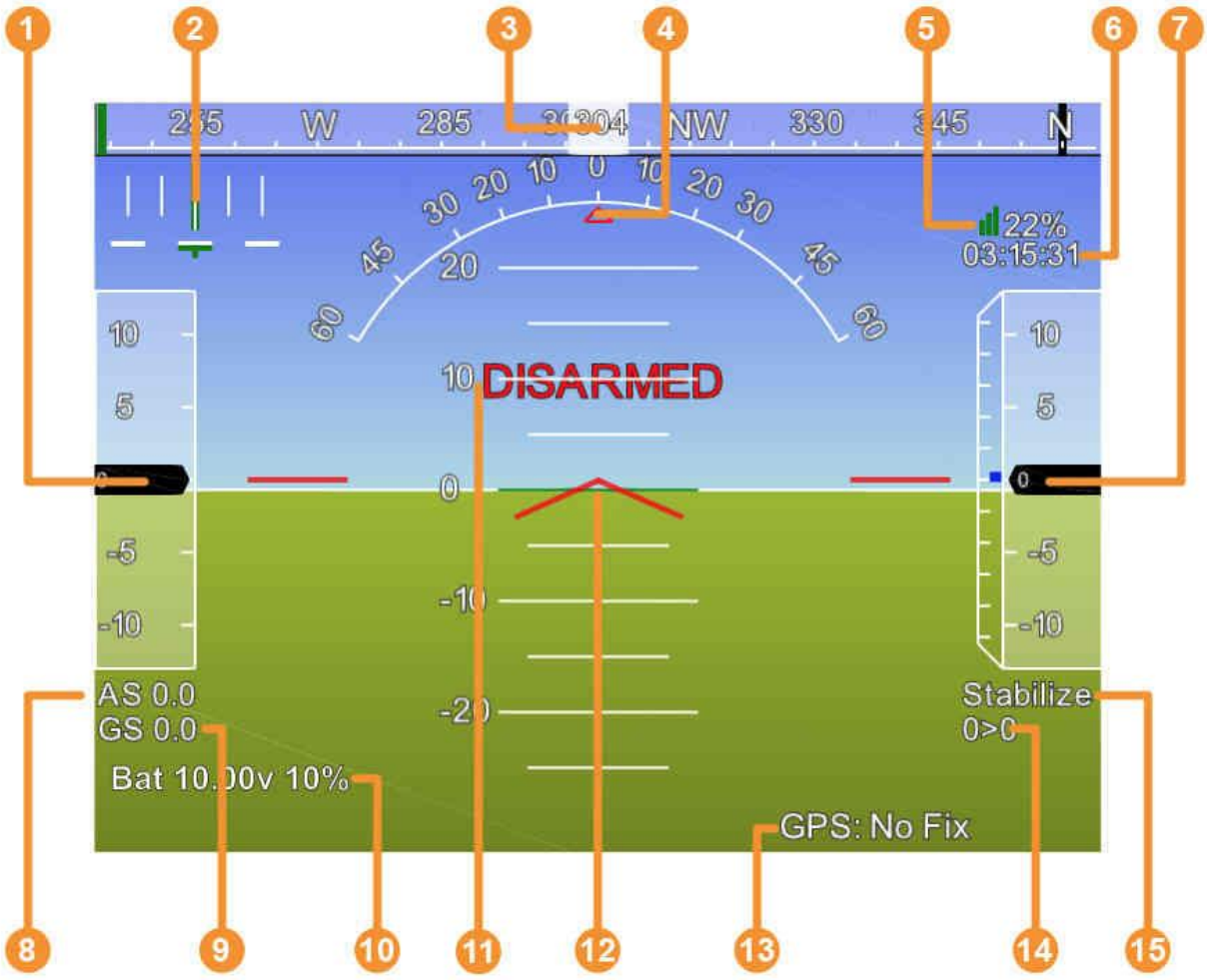
Instrument panel

The instrument panel is the GCS (running Mission Planner software). Documentation on Mission planner can be found here: http://ardupilot.org/planner/docs/mission-planner-overview.html

Below is an overview of the Mission Planner instrument panel:



A more detailed view of the HUD window (with legend) is given below:



Wing flap system

The flaps are only controlled in manual mode. We use two positions for landing; half flap and full flaps. In addition we use 5-10 degrees flaps during launch.

Landing gear

As the CW Observer is belly landed, it does not have a conventional landing gear. It does have a reinforced plate under the belly to protect the styrofoam.

Takeoffs will be primarily hand launch. In cases where the flight will be at MTOW it might be preferable to use a bungee cord or equivalent launching method.

Payload compartment

The payload compartment is located in the pod beneath the wing. Mounting of payload in other places on the airframe requires permission from the technical leader.

Engine

The CW observer is powered by one Dualsky XM4255EA-4.5 brushless motor.

Engine controls

The engines can be manually controlled by the throttle stick on the RC pilots transmitter (while in manual mode).

Note that engine controls are disarmed at system power on. First, the PWM signals to the servo outputs must be enabled by pressing the **pixhawk safety button.** Next, the autopilot must be armed. See the Throttle arming documentation.
There are two ways of arming the throttle:

1. Arm the throttle via the ground control software.

OR

2. Arm the throttle by applying full right rudder input for several seconds.

To arm throttle in Mission Planner, use the Flight Data screen, then select the Actions tab. This provides an “Arm/Disarm” button that can be used to arm and disarm the throttle.

Engine instruments

There is no engine instruments. However, the voltage and current as well as milliamperes drawn from the battery can be used to observe that the system is working properly.

Engine oil system

NA

Air induction system

NA

Exhaust system

NA

Cooling system

The motor is cooled by ram air running through and around the engine. The ESC has a heatsink designed to dissipate heat into the surrounding air.

Propellor

Propellers to be used will be determined after flight and bench testing. It will be an APC Electric propeller with fixed blades.

Fuel system

The CWM Observer is electric and is power by one onboard 4cell Li-Poly battery. Minimum and maximum capacity will be determined after flight testing.

Electrical system

There is one main electrical system onboard. Motors, avionics and payload is supplied from the main batteries.

Ammeter

The current and voltage is sensed through the 3DR Power module (or equivalent). This data is fed into the Pixhawk autopilot and and is available on the GCS. (See section 8.4 Instrument panel).

Fuses

Payload and other non-flight critical systems shall be connected to the main circuitry through suitable fuses.

Lighting system

The Observer will be equipped with a white flashing strobe light. Night flying is not permitted until a full set of navigation lights is implemented.

Pitot-static system and instruments

The pixhawk measures airspeed using a pitot tube connected to a digital airspeed sensor (static and dynamic pressure sensors). The Pixhawk relays the pitot static information to the GCS, where it is displayed in Mission planner

Airspeed indicator

As the airspeed sensor is calibrated during flight, by calculating the offset between GS and IAS, the figures provided in the GCS is actually CAS. Note that the airspeed is indicated in m/s units. The airspeed indicator is located in the GCS HUD window, see section 8.4 Instrument panel.

Rate-of-Climb indicator

The Rate-of-Climb indicator is located in the GCS HUD window, see section 8.4 Instrument panel

Altimeter

The altimeter is located in the GCS HUD window, see section 8.4 Instrument panel. Note that the altimeter shows the altitude in meter above ground (starting position).

Flight instruments

The Pixhawk autopilot relays the flight information to the GCS, where it is displayed in the Mission planner software.

Attitude indicator

The attitude indicator is located in the GCS HUD window, see section 8.4 Instrument panel.

Directional indicator

The directional indicator is located in the GCS HUD window. It is also available in the map window, see section 8.4 Instrument panel.

Aircraft handling, service & maintenance

Introduction

Building a new aircraft

Building of a new aircraft is to be done according to the build documentation approved by the Technical leader. The building is finalized by assembling the aircraft binder containing the build documentation, aircraft log, aircraft maintenance log, aircraft flight log and tickets form. The aircraft log contains information regarding changes made to the aircraft from new. The aircraft maintenance log contains scheduled maintenance. The Aircraft flight log is the log that is filled out with every flight. The ticket is a log of unscheduled maintenance. Se appendices for log forms and ticket form

After first assembly:

Technician signs off on a complete and ground tested UAV.
complete a airframe check out form

Identification plate

The aircraft is marked with registration number generated according to procedure provided by the CAA, Norut's logo, name and telephone number.

Airplane binder

The aircraft binder contains the build documentation, aircraft log, aircraft maintenance log, aircraft flight log and tickets form. The aircraft log contains information regarding changes made to the aircraft from new. The aircraft maintenance log contains scheduled maintenance. The Aircraft flight log is the log that is filled out with every flight. The ticket is a log of unscheduled maintenance. Se appendices for log forms and ticket form

Airplane inspection periods

Daily inspection before every flight.
Major inspection between TBD flights

Alterations or repair

Small alterations and repair can be made in the field if deemed necessary and approved by competent crew using best practice methods. Check build manual to see if the procedure is covered there

Service

The aircraft is assembled and disassembled in order to be packed for shipping in such an extent that minor and major faults are detected easily. In combination with the thorough DI and walk-around we don't see the need for a complete disassembly of the aircraft at fixed intervals.

Ground handling

Plane storage and shipping

The plane is stored and shipped in a custom box. Before long time storage, ensure that the aircraft is dry and remove the batteries.

Supplements

Introduction

Supplements

List of optional equipment that may be installed