University of Colorado Boulder
Unmanned Aircraft Systems
Flight Operations Training Manual

This manual has been approved by the following representatives:

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Contents

Chapter 1. Introduction

1.1 Motivation

This purpose of this document is to outline the training curriculum and certification requirements for UCB UAS users and pilots. The training section of this document will cover all relevant areas of study needed to safely operate different types of UAS in accordance with UCB practices. The Airman Certification Standards section of this document will cover requirements for what is needed to pass the practical exams needed in order to be recognized by UCB as a certified UAS Pilot, Visual Observer, hold an additional certification.

1.2 UCB UAS Operations and FOTM Purpose

The University of Colorado Boulder's Office of Integrity, Safety and Compliance Flight Operations Department oversees all UCB related UAS operations. With the intent of being an unbiased administrator for UAS operations, the department strives to publish outlines and standards for conformity and reference. One task of the OISC Flight Operations Department is to provide basic training to all UCB personnel intending to operate UAS under a university issued COA or in some other relation with or to the University of Colorado, Boulder. With OISCs direct goals to enhance safety, integrity, and compliance the training and certification sections of this manual has been created to provide a more complete and standardized process documenting the specific subject areas pertaining to learning new UAS related information. The OISC Flight Operations Department administers ground schools, training events, checkrides, and evaluation visits to ensure all certified personnel have the required knowledge, risk management, and skills.

1.3 Document Structure

This document is split into two main parts, with sections pertaining to training curriculum and sections pertaining to airman certification. Training curriculum sections have been published to provide a detailed outline on curriculum structure and relevant information relating to the stated sections title. This has been done so that all training follows a familiar and similar format regardless of the CFI or administrator providing the instruction. Airman Certification Standards (ACS) sections have been published to communicate the aeronautical knowledge and flight proficiency standards required to obtain different UCB recognized UAS certifications. All UCB certification processes will be upheld to these standards to ensure each applicant possess the required knowledge, risk management, and skills to operate under that certificate. This has been done so that certification follows a familiar and similar format regardless of the examiner or evaluator conducting the certification process. The goal of these sections is to reduce and eliminate subjective opinions, clearly state or publish testing standards, and create equality in the certification process.

Although certain training curriculum differs for each unique type of UAS, there is general knowledge that forms the basis for all UAS operations. For that reason, the training curriculum starts with a "General" section which provides a layout for training applicable to all UCB UAS flying. Specific training sections following the "General" section which cover the training procedures relating to four different categories of UAS: Multirotor, Fixed Wing, Helicopter, and Airship. Additional training sections for nonstandard training or for new flight environments follow; this section includes sections for night, new COA, and on campus training. A section for visual observer (VO) training is also included.

The original issuance for recognition as a UCB certified pilot requires the general training as well as the UAS multirotor specific training and practical test to difficulty level 1 multirotor category standards. For this reason, additional specific UAS training sections may not recover the basic topics which were learned in the preliminary specific multirotor PIC training and certification sections. Furthermore, some training maneuvers and discussion topics presented in the specific training sections may not be tested in the ACS but are listed to provide students with additional knowledge to future enhance safe UAS operation.

The specific training sections are an outline of the training curriculum and do not include detailed descriptions of subject material, for more detail on the specific training sections please reference the appendix section or consult a CFI.

Airman certification standards are the last sections listed in this document. The certification standards outline what knowledge, risk management, and skills are required to pass a UCB checkride. The certification standards will be used for evaluation in both the oral and flight potions of the exam. Testing sections cover all relevant aspects of training and real-world scenario-based applications. Each ACS testing section has categories that list of that section's objectives, document references, required knowledge, risk management, and objective skills. The ACS is published for almost all practical tests that OISC Flight Ops department conducts. Practical tests are practical in nature and designated to evaluate students in a manner which is realistic and similar to conditions and scenarios found when operating in the real world. Most practical tests consist of a ground and flight portion. For more specifics on ACS testing reference the specific ACS testing section.

Chapter 2. Training Curriculum: General – Initial Ground School Material and Curriculum

2.1 Introduction Thoughts

2.1.1 Introductions

2.1.2 Course Overview

2.1.3 OISC Flight Ops Roles and Background

2.1.4 Flight Ops Website

- Resources
- Ground school documents
- Training videos
- Contacts

2.1.5 Review of Ground School Documents

2.1.6 UAS History

2.1.7 Rise of Regulations

- New hobbyist regulations
- Commercial operations
    - Lawrence letter

2.1.8 National Airspace System Introduction

- FAA importance and control
- Ways to access NAS

2.1.9 UCB Roles as Public Entity Relating to NAS and COAs

2.2 Important FOM Definitions

2.2.1 ADS-B

- Function
- Future Implications

2.2.2 Advisory Circular

- Reason for publication

- Regulatory in nature

2.2.3 Airworthiness Directive
- Example of when one would be published

2.2.4 Airworthiness Manual
- Applicability to students and departments

2.2.5 AGL
- Provide example

2.2.6 Associate Vice Chancellor
- Authority
- Impact with Flight Operations Department

2.2.7 Category

2.2.8 Class

2.2.9 Cloud Ceiling
- Distinguish difference between cloud and ceiling

2.2.10 COA

2.2.11 Continuing Airworthiness
- Preflight Inspections
- Maintenance logs
- Relate to Initial Airworthiness

2.2.12 Crewmember
- Briefly describe different classifications

2.2.13 UCB Flight Instructor

2.2.14 Day
- Day vs night flying
- Important times

2.2.15 Difficulty Rating
- Importance on initial certification requirements

2.2.16 Director of Flight Operations
- Roles and contacts

2.2.17 Duty Time
- Delineation and difference between flight time
- Blanket COA duty times
- Emphasis that the duty day clock is on going

2.2.18 Federal Aviation Regulation
- References to this manual

2.2.19 FAR1

2.2.20 FAR67

2.2.21 FAR89
- New regulations

2.2.22 FAR91

2.2.23 Flight Operations Manual

2.2.24 Flight Operations Training Manual

- Training standardization and testing standards relevant to students

2.2.25 Flight Time

- Rounding requirements
- Logbook entries
- Logbook locations
- Difference between duty times

2.2.26 Hobbyist

2.2.27 Initial Airworthiness

- Relationship to continuing airworthiness

2.2.28 MSL

- Provide example
- Difference between AGL

2.2.29 National Airspace System

- Reiterate exclusive FAA control

2.2.30 Night

- Required addition training
- Reiterate time requirements

2.2.31 NOTAMs

- UCB COA uses
- Other NOTAM uses
- Publications

2.2.32 Pilot at the Controls Manual

- Use in training

2.2.33 Pilot at the Controls Operator

2.2.34 Pilot in Control

2.2.35 Public Aircraft

- Importance on COA uses

2.2.36 Quick Reference Handbook

2.2.37 Remote ID

- Relation to FAR89

2.2.38 Section 333 Exemption

2.2.39 Toy Drones

2.2.40 TFR

- Examples of common publications
- Consequences of violation

2.2.41 Type

2.2.42 Typerating

2.2.43 UA

2.2.44 University of Colorado Boulder

- Abbreviation

2.2.45 Unmanned Aircraft System

2.2.46 Visual Line of Sight Aircraft Operation

- Visual aids
- Attitude and orientation determination
- FPV/Camera
- VO role and privileges
- Ask scenario-based questions and examples

2.2.47 Visual Meteorological Conditions

- Relation to could clearance

2.2.48 Visual Observer

- Importance to COA operation
- Training requirements

2.2.49 Very High Frequency Omnidirectional Range

- Abbreviation
- Importance to NOTAMs

2.3 Important FOM Chapter 2 Sections

2.3.1 UAC

- Brief overview of importance of group agreement and decision making
- Important representatives
- Meetings

2.3.2 DO

- Importance to program
- Authority
- Direct contact with FAA

2.3.3 Adherence to regulations

2.3.4 Responsibility and authority of PIC

- Importance of this role on safety
- Public and university trust in PICs

2.3.5 Delegation of authority

- PIC role importance
- Final authority and responsibility of safety
  - Important iteration that no employer, superior, or mission leader can overturn PIC decision
- Examples

2.3.6 Crew duties

- PIC, PAC-M, PAC-O, VO, ML
- How to split up roles for bigger missions
- Examples of PIC vs PAC-O in logging

2.3.7 In-flight crew change

- Required briefing
- Example

2.3.8 Minimum crew complement

- COA requirements

2.3.9 Crew qualifications

- Training required
- UAS categories, difficulty levels, and typeratings
- VO stipulations

2.3.10 Flight currency

- General rule
- Variations on different UAS
- Night differences
- Logbooks
- Priority on retraining

2.3.11 Fatigue

- PIC final authority on safety
- Pressure from mission leader

2.3.12 FAA notices

- Reiterate the DO as direct POC with FAA

2.3.13 English language proficiency

2.3.14 Preflight action

- Becoming familiar with all available information
- Specifics

2.3.15 NOTAM submission

- Submission website
- Format
- Center point clarification
- Size and time practical requirements

2.3.16 Flight Plans

2.3.17 Safety

- Safety
- PIC thoughts and considerations
- Making flights and teams safer

2.3.18 Right of way

- Examples of avoiding other UAS and manned aircraft

2.3.19 Flight times

- Flight times vs fatigue
- Other COA stipulations

2.3.20 Stabilized approaches

- Applicability to real world operations
- Additional safety

2.3.21 BVLOS approaches

- Applicability
- Describe actual approach

2.3.22 Flight over congested area

- Defining congested areas
- Safe operations and considerations

2.3.23 Radio communications

- Applicability

2.3.24 Sterile operations

- Applicability to real world operations
- Importance on safety

2.3.25 Operation near military training routes

- Specific distances
- How to coordinate and deconflict

2.3.26 Careless or reckless operations

- Overall statement on PIC safety
- Common sense

2.3.27 See and avoid policy

- Importance of VOs

2.3.28 Extreme maneuvers

- Specific angle and pitch degrees
- Emergency exemptions

2.3.29 Crew briefings

- The three briefings
- Examples

2.3.30 Checklist usage

- Importance
- Examples
- Creating new and modified checklists

2.3.31 Dropping objects

2.3.32 Fatigue management

- Definitions
- General rule
- Variations on time limits with additional work days
- Rest periods

- Max times

<u>2.3.33 Ceiling and visibility requirements</u>
- Details
- Practicalities

<u>2.3.34 Cloud clearance requirements</u>
- Details
- Practicalities

<u>2.3.35 Medical requirements</u>
- Requirements
- Actable ways to comply with requirements

<u>2.3.36 Operations with a known medical deficiency</u>
- Responsibility and safety
- Example

<u>2.3.37 Alcohol and drug use</u>
- Specific minimums
- Federal licenses and state laws

<u>2.3.38 Corrective lenses</u>

<u>2.3.39 General Aeromedical Considerations</u>
- Safety considerations
- Mnemonics

<u>2.3.40 Aircraft ownership</u>
- Reason
- Minimum times

<u>2.3.41 UAS flight manual, marking, and placard requirements</u>
- Aircraft registration
    - Different for commercial operators and hobbyist
- Scam websites
- Current registration placard requirements

<u>2.3.42 Aircraft Discrepancies</u>
- Maintenance logging system
- Examples
- Differences between logbooks, SARs, and maintenance logging system

<u>2.3.43 Required documentation</u>
- FOM
- COA
- Checklist
- Electronic versions
- Additional considerations

<u>2.3.44 Master logbook</u>
- Departmental Importance
    - Monthly totals reported

- Actual COA IDs
- Time format

2.3.45 Individual pilot logbook

- Importance
- Definitions
- VO entries

2.3.46 Notifications for flights over UCB property

- Supplemental training
- Coordination requirements
- All flight locations

2.3.47 CUUF procedures

2.3.48 Professional photo and video licensing

2.3.49 Flights near residence halls

- Reiteration of on campus training

2.3.50 Accident investigation

2.3.51 Safety action report

- What requires SAR
  - Provide examples
- Submission
  - DO office (Direct contact to FAA statement)
- Submission available by any crew member
- SAR compliance mandatory

2.3.52 Internal evaluation manual

- Importance
- Relevance
  - Compliance visits
- Reiteration on safety

2.4 METARs

2.4.1 How To Read A METAR Document

- FAA weather reports importance
- Origination (locations and stations)
- Understanding date codes
- Wind direction
  - Limitations on UAS
- Weather descriptors
  - Specifics
  - Finding unfamiliar codes
- Ceiling descriptors
  - Which descriptors constitute a ceiling
  - Avoiding confusion between ceiling and weather descriptors
  - AIM definition of ceiling

    - COA requirements
    - Cloud clearance vs ceiling requirements
- Visibility
    - Different depictions
    - COA requirements
- ACS requirement to determine
    - Visibility and Ceiling level
- FAA recorded and archived statement or decision making

2.4.2 METAR Examples

- Where to find them
    - www.Skyvector.com
    - Third party
- Simple vs complex METARs
    - Ability to in finding the required information
- Determining weather at locations between or not near airports
- Limitations of weather measuring devices
- “Could we fly there” examples

2.5 Sectional Charts

2.5.1 Available Airspace Guides

- Airspace guide
- Airspace visualization
- VFR Sectional chart legend
- 3D models

2.5.2 Resource Access

- SkyVector
- AirNav
- FAASUA
- Google Earth
    - Chart installation process

2.5.3 Entire Chart Overview

- Teaching strategy overview
- “Correct answer, proper reasoning, and confidence” standards
- General purpose of airspace
- Color notation for ground elevation
- “Four dimensional” airspace chart
- Identify all airspace A-E at a high level
- Higher class dominates

2.5.4 Airport Related Specific Information

- Airport color differences
- Runway symbol
    - Circle vs runway notation (8069ft)
- ICAO ID

    - K vs P prefix
- AWOS/ASOS/ATIS
- Elevation MSL Height
- Lightning symbol
- Runway length
- CTAF
- Unicom
- Pattern denotation
- Beacon symbol
- Airport tick marks
- Private vs public notation
    - Importance to COA
- Closed airports notation
- Nonstandard airport depiction
- Heliport
    - Non charted heliports
        - Importance to COA

2.5.5 Navigation Aids

- Typical symbols
- Communication boxes
    - Identification
    - Frequency
- Magnetic vs true heading

2.5.6 Airspace Depiction

- Class A
    - Typical altitude and location
    - Requirements for flight
    - Memory item
- Class B
    - Common locations
    - Shelves
        - Fractional notations
        - Typical dimensions
    - Mode C vail
        - Distinguish difference with class C airspace
    - Memory item
- Class C
    - Common locations
    - Shelves
        - Fractional notations
            - Altitude detection: normal and with minus sign
        - Typical dimensions
    - Discuss magenta shading with blue airport meaning
    - Memory item
- Class D

    - Common locations
    - Areas
        - Notation
            - Altitude detection normal and with minus sign
        - Typical dimensions
    - Memory Item
- Class G
    - Common locations
    - Denotations
        - Magenta shade
        - Blue zipper
        - Blue shade
    - Definition of uncontrolled airspace
    - Memory Item
- Class E
    - Common locations
    - Denotations
        - Magenta dashed
- Memory Item

2.5.7 Special Use Airspace (SUA)

- Nonregulatory
    - Alert area
    - Controlled firing area (CFA)
        - Not depicted
    - MOA
    - Warning areas
    - National Security Area (NSA)
    - National parks
- Regulatory
    - Restricted
    - Prohibited
- ADIZ
- TFRs
    - Quick reiteration on how to look up TFRs
- Common depictions for all SUA
- Locations for active times for all SUA
    - tfr.faa.gov
        - highlight that this is the most accurate and reliable source
    - sua.faa.gov
    - skyvector.com
        - adjustments to chart stitching modes

2.5.8 Other Chart Symbology

- Latitude and Longitude
- Isogonic lines
    - Lines of variation

- State lines
- Roads
    - Bridges
- Railroad tracks
- Power Transmission Lines
- City/Town/Lake names
- Population denotation
- Towers
    - Heights vs size
    - Altitudes
    - Lights
- Rivers
- lakes
- VFR checkpoints
- Victor airways
- GPS Airways
    - GPS fix
- MTRs
- Speedway / stadium
- Operations areas
    - Parachute Jumping Area
- Gliders/ Hang Glider/ Ultralight/ Unmanned Aircraft

2.5.9 Revisions

- Airspace reversions
    - Typical airspace reversions
        - Class C
        - Class D
        - Class E
        - SUA
    - Resources to find reversions
        - AirNav
        - sua.faa.gov
        - Skyvector
            - Chart supplement

2.6 COA

2.6.1 Title

- Decoded meaning

2.6.2 Issuance

- UCB public entity relationship
- Public aircraft correlation

2.6.3 Operations Authorized

- Importance of general overview

- Found on all other UCB COAs

2.6.4 Waived Regulations

2.6.5 Standard Provisions

- Previous COA Application Statement
  - Reason for COA NOTAM location specified from NAV distance

2.6.6 Special Provisions

- General
  - Responsibility/accountability
  - Reintroduce COA availability to crew
  - COA cancelation
  - Evaluation/Audit/Visit possibility
  - Frequency spectrum
    - COA has authority to fly in airspace does not talk on radio
- Operations
  - VLOS
    - FPV/POV restrictions
  - Right of way
  - Altitudes
    - Reintroduce structure altitudes
  - Visibility
  - UAS
  - Non stationary flight lines
  - Lost link
  - Emergency response
    - Operations outside of approval
- Notice to Airmen (NOTAM)
  - Submission time requirements
  - Database location for submission
    - Local base operations or (D) NOTAM issuing authority
    - NOTAM flight service
      - 1800wxbrief website
        - Account creation
          - "Association" as last name
          - Required Video allow COA input
  - Area of operation
    - How to define location
      - Decimal for location
  - First responders' exemptions
- Reporting requirements
  - DO office requirements
    - Logbook importance
- sUAS Night Operations
  - Additional training
  - UAS lighting requirements
- Maximum and Minimum Altitudes for Operations

    - Groundspeed
    - Operations over people
    - Airspace
- Special Use Airspace
    - MTRs & SUA
        - How to coordinate and deconflict
- Flight Planning Requirements
    - ARP meaning
    - AFD location
    - Distance requirements for different airports
- Emergency/Contingency Procedures
    - Lost link
        - UAS type specific knowledge
    - Emergency fly away procedures
- Preflight planning importance

2.6.7 Effective Dates

2.7 Operational Risk Management (ORM)

2.7.1 Purpose

- Typical risk management analysis
- Importance
    - Drafted from similar air force document
- Visibility into mission's riskiest aspects
    - PIC decision making
    - Mitigation on risk discussion
- Nonmandatory but recommended

2.7.2 Common Mission Risks

- Launch/landing site
- Personnel
- Airspace
- Aircraft
- Forecast enroute weather
- Equipment
- Launch type

2.7.3 Other Benefits

- Careless and reckless charges
- Risk matrix control column

2.8 Export Controls

2.8.1 Available Documents

- CU: Intro to Export Controls
- Export Control Regulations and UAS Research FAQs
- "Exporting" controlled technology to other countries

2.8.2 Purpose

- Common occurrences and UAS request
- Highlight safety concerns
  - Additional risk
  - New/differing regulations
  - Controlled technologies
  - Military ratings and thoughts on UAS

2.8.3 Resources

- Contacts

2.8.4 Training

- SkillSoft
- Other country regulations
- Possible meetings with different CU departments

2.9 FOM Chapter 3 Important Topics

2.9.1 Authority

- UCB can train and certify pilots as we see appropriate

2.9.2 Delegation

- Committee elected DO
- Associate Vice Chancellor

2.9.3 Privileges of each crew position

- Focus more on VO and PIC sections

2.9.4 Training Programs

2.9.5 Typeratings and PIC qualifications on multiple UAS

- Reiterate typerating definition
- Reiterate difficulty level
- Provide example

2.9.6 Records

- Training records in folders
  - Request within 48

2.9.7 Crew disqualifications

- General careless and reckless statement
- Compliance visits

2.9.8 Initial VO Requirements

2.9.9 Practical Test Requirements for PICs

- Common testing procedures and time
- Requests for VO training

2.9.10 Biannual recurrent training

- VO specific and reason
- Reiterate no VO logbook entries required

2.9.11 Initial PIC Requirements

- Outline common student progression

2.9.12 Practical test requirements

- What to expect on a test example

2.9.13 Biannual recurrent training

- Establish difference between currency
- Flight review requirements
- Skillsoft training course
- How to reset BFR clock
- Example of when one would be needed

2.9.14 Specialized training

- Reason
    - List of when and for what specialized training is required

2.9.15 Checkride standards

2.9.16 Practical Test Failures

- Retraining at discretion of DO
- Time required after fail

2.9.17 Training Recency

- Correlation between time after training even and test success

2.9.18 Cancellations

2.10 FOM Chapter 4 Important Topics

2.10.1 Authority

- OISC flight ops is designated to have privileges to both certify and take airworthiness

2.10.2 Oversight

- Initial airworthiness certifications
    - Limitations and restrictions
    - Issuance for non-commercially produced or heavily modified

2.10.3 Airworthiness certification manual

- Overview on the manual breakdown
- Applicability
- Airworthiness types
- Type vs airworthiness certificates
- Allowed evaluation personnel

2.10.4 Initial Airworthiness

- Applicability
- Obtaining a certificate
- Previous approvals
- Parts and batteries

2.10.5 Airworthiness directives

- Applicability
- Mandatory statement

2.10.6 Payloads

- Relevance to airworthiness
- Examples

2.10.7 Modified and repaired aircraft

- Required additional inspections
- Exemptions
- Actions required after modification

2.10.8 Flying difficulty evaluation

- Different difficulty ratings
- Applicability

2.10.9 Continuing Airworthiness

- Responsibility of PIC
- Functional check flights

2.10.10 Student projects

2.11 FOM Chapter 5 Important Topics

2.11.1 Applicability

2.11.2 Part 107 Operations Not Over UCB Property

- Varying liability
- UCB Approved Part 107 Operators List
    - Note list has been removed from appendix
- Notification requirements
    - For flights
    - For accidents or incident reports

2.11.3 Part 107 Operations Over UCB Property

- Requirements
- DO application and written authorization

2.11.4 Hobby Exemption Users

2.12 FOM Chapter 6 Important Topics

2.12.1 Applicability

- What constitutes weight
- Common toy drone examples

2.12.2 Operational rules

2.13 FOM Chapter 7 Important Topics

2.13.1 Applicability

- Hobbyists flying on UCB property clearification

2.13.2 Academy of Model Aeronautics

- Membership
  - Register number with campus
- Safety code and FAA regulations
- Liability insurance

2.13.3 Flight Areas

- Main Campus
- East Campus
- South Boulder Campus
- Williams Village

2.13.4 Flight requests

- General request and varying requirement for different locations

2.14 FOM Chapter 8 Important Topics

2.14.1 Applicability

- Exporting UAS to locations outside the US
- Foreign national(s) having access to possibly controlled technical UAS data
- Military standards vary between US and other nations

2.14.2 Specific Rules and Classifications

- Varying laws between nations
- UAS classified as weapons in other nations

2.14.3 Additional Resources

- Previously discussed additional documents on export controls and FAQs

2.15 FOM Chapter 9 Important Topics

2.15.1 LIPO Battery Storage

- Review of guidelines
- Inspections
  - Effects of damage on inherently safe technology
- Good practices
- Environmental health and services department available for disposal of LiPos.

2.15.2 Battery Types

- Possible benefits and issues with different battery types
- Examples of previous issues with compatibility between smart and standard batteries

2.15.3 Propeller Safety

- Mounting and securing propellers
- Propeller safety and ideology

2.16 FOM Chapter 10 Important Topics

2.16.1 Applicability

2.16.2 Process

- Where to find required information
- Contacts
- Common procedures for international operations
- Requirements

2.17 SARs Submission Format

2.17.1 General Format

- Where to find

2.17.2 Rules

- Reiterations on what warrants a SAR
  - Accident vs Incident
- 24hr submission deadline
  - Reiterate SAR submission direct to DO office

2.17.3 Additional notes

- Picture suggestion
- Legal definitions
- Type(s)
- Post-accident checklist

2.18 Complex Airspace Examples

2.18.1 Review of airspace

2.18.2 Complex examples

- Densely populated and compact airspace environments
- Class D and E airspace reversions at different times
- TFRs
- Rework SUA active times
- Using resources to find unknowns
- Teaching a systematic approach to all problems
- Following COA flight checklist complete multiple “real world” examples

Chapter 3. Specific Training Curriculum: Multirotor

3.1 Multirotor Definition

3.1.1 Definition

3.2 Multirotor Uses

3.2.1 Typical uses/missions

3.2.2 Risk associated with multirotor and related missions

3.2.3 Training type flying

3.3 Multirotor Characteristics

3.3.1 General characteristics

3.3.2 Common multirotor components - general

- Power - Battery
- Propulsion – Motor and propellers
- Electronics – ESCs, flight controller, lights, payload
- Frame – Construction

3.3.3 UAS axes

- Lateral, Longitudinal, Vertical
- Orientations for flying

3.3.4 Maneuverability

- Ability to change multirotor pitch, yaw, and roll with controllable components

3.4 Remote Control Basics

3.4.1 General concept

3.4.2 Radio wave propagation

3.4.3 Transmitter

3.4.4 Receiver

3.4.5 Multirotor Controllability

- Demonstrate how controller changes an input which effects each axis

3.4.6 Possible RC errors

- Frequency interference
- Antenna placement and propagation

3.5 Introduce the Training Multirotor

3.5.1 Introduce the multirotor used for training

3.5.2 Show storage techniques

- LiPo location and safety

- Folding booms
- Gimbal cover
- Transmitter storage

3.5.3 Demonstrate assembly

- LiPo connections
- Arms and booms
- Gimbal checks
- Transmitter
- Propellers

3.5.4 Describe unique systems

3.5.5 Review UAS checklist

3.5.6 Review maintenance records

3.6 Multirotor Training Flight

3.6.1 Prior to Training Event Arrival

- Set and confirm date and location
- Describe training flight plan, objectives, and expectations to student
- Check and review NOTAM with student if applicable
    - 24hrs in advance file backup NOTAM
- Confirm charged battery(s)
- Confirm all UAS components are packed and ready for transport
- Review all student and CFI qualifications and documents

3.6,2 Arrival and Preflight Preparation

- UAS unpack and assembly
- Checklist usage
    - Explain reason behind important checklist steps
    - Define unfamiliar UAS components
- Controller start and or boot sequence (if applicable)
- Common controller GPS errors (if applicable)
    - Remedies
- General screen indications and instrumentation (if applicable)
- Software (if applicable)
- Battery and charge level indicators
- FPV connection (if applicable)
- Controller control inputs
- Control review and hands on demonstration
- Camera controls (if applicable)
- Emergency buttons/switches

3.6.3 Initial Crew Briefing

- Describe flight maneuvers
- Denote safest area to fly
- Denote typical flight patterns/areas for training maneuvers

- List possible safety hazards
- Formulate plan of action for any foreseeable emergencies
- Describe situations which would require exchange of controls
    - State positive exchange of control procedures
- Demonstrate summarized crew briefing

3.6.4 Takeoff

- Describe multirotor takeoff sequence
- Reiterate takeoff technique
- Review checklist
- Commence instructor or student take off

3.6.5 Initial Flight Familiarity

- Allow student to experience different control inputs at safe altitude
    - Control inputs effecting pitch
    - Control inputs effecting roll
    - Control inputs effecting yaw
    - Multiple control inputs
- Review and show initial controller features and displays (if applicable)

3.6.6 Introductory Flight Maneuvers

- Box pattern
    - Flight box pattern with reference to ground
    - Emphasize smoothness of controls
    - Emphasize ground track and even leg distances
    - Describe control lag and system response
    - Describe and demonstrate overshoot (if applicable)
- Straight transects
    - Flight in one direction in straight line
    - Describe drone ability to hold altitude with changes in other control inputs like pitch
    - Describe and demonstrate the change in UAS visibility to determine orientation with distance
    - Flight to maximum VLOS to provide coordination between the VLOS definition and the actual sight picture.

3.6.7 Complex Flight Maneuvers

- Circle around a point
    - Emphasize smoothness and small corrections when using combined control inputs
    - Describe how applying different control inputs can affect drone attitude
    - Gain exposure to flying in the “region of reverse command”
    - Emphasize goal and reason of trying to achieve uniform circle

3.6.8 Emergency Procedures

- Lost orientation exercise
    - Flight on limit of VLOS
    - Instructor maneuvers multirotor to induce disorientation

    - Upon student receiving the controls, must regain orientation
        - Teach knowledge of controls and effect on flight
- Lost link / fly away
    - Describe possible situation
        - Demonstrate if applicable
        - Relate responses from student to preflight preparation
- Low fuel or battery scenario
    - Describe scenario requiring emergency landing
    - Have student demonstrate controlled return flight
        - As fast as safe and practical
        - Goals in doing this
    - Describe Multirotor features for returning to home

3.6.8 Normal Landing

- Describe typical landing procedure
    - Landing briefing
    - Approach at safe altitude
    - Determining landing zone
    - Clearing the area
    - Vertical decent
    - Final landing stage and touchdown
    - Motor shut down

3.6.10 After Landing

- Multirotor shut down
    - Battery change sequence
- Controller shut down
- Multirotor disassembly
- Checklist usage
- Post flight briefing
- Logbook
- Allocate time for student questions

Chapter 4. Specific Training Curriculum: Fixed Wing

4.1 Fixed Wing Definition

4.1.1 Definition

4.2 Fixed Wing Uses

4.2.1 Typical uses/missions

4.2.2 Risk associated with missions

4.2.3 Training type flying

4.3 Fixed Wing Characteristics

4.3.1 General characteristics

4.3.2 Common fixed wing components

- Power - Battery
- Propulsion - Motor
  - Gas/glow
  - Electric
  - Propellers
- Electronics
- Airframe structure and components

4.3.3 Define axis

4.3.4 Maneuverability

- Concepts for varying pitch, yaw, and roll
- Control surface effects

4.3.5 Typical flight patterns

4.3.6 New flight characteristics compared to previously flown UAS

4.4 Remote Control Basics

4.4.1 Review of concepts and any changes of remote-control basics when compared to this new UAS type

4.5 Introduce the Fixed Wing Training Aircraft

4.5.1 Introduce the fixed wing aircraft used for training

4.5.2 Show storage techniques

- LiPo or battery storage
- Fuel drain or storage (if applicable)
- Disassembly

4.5.3 Demonstrate assembly

4.5.4 Describe unique systems

4.5.5 Review checklist

4.6 Fixed Wing Training flight

4.6.1 Prior to arrival

- Set and confirm date and location
- Describe training flight plan, objectives, and expectations to student
- Check and review NOTAM with student (if applicable)
- Confirm charged battery(s)
- Confirm all UAS components are packed and ready for transport
- Review all student and CFI qualifications and documents

4.6.2 Preflight preparation

- UAS unpack and assembly
- Checklist usage
    - Explain reason behind important checklist steps
    - Define unfamiliar components
- Controller start and or boot sequence
- FPV connection (if applicable)
- Buddy Box connection and test (if applicable)
- Controllers switches and controls
    - Control surface review and demonstration
        - movement of controls surfaces
    - Camera controls (if applicable)
    - Dual rates
    - Landing gear (if applicable)
    - Flaps (if applicable)
    - Run up
    - Emergency buttons
- Control review and hands on demonstration
- Camera Controls (if applicable)
- Emergency buttons

4.6.3 Initial crew briefing

- Describe flight maneuvers
- Denote safest area to fly
- Denote typical pattern
- List possible safety hazards
- Formulate plan of action for any foreseeable emergencies
- Confirm loss of control procedures and instructor take over actions
    - Positive exchange of controls
- Demonstrate summarized crew briefing

4.6.4 Starting Engine

- Discuss safe areas for engine start

- Discuss risks and hazards with engine start procedure
- Prebrieff any possible emergencies and their remedies
- Review then demonstrate engine start

4.6.5 Taxi

- Normal taxi procedure
- Controls for taxiing
    - Rudder steering
    - Wheel steering (if applicable)
    - Differential trust (if applicable)
- Controls placement for wind corrections
- Abnormal or rough terrain taxi procedure

4.6.6 Takeoff

- Normal Runway Takeoff
    - Describe fixed wing normal takeoff sequence
    - Reiterate takeoff technique and reasons
    - Commence instructor or student take off
- Hand launch bungee (if applicable)
    - Describe bungee system
        - Mounting system
        - Aircraft detach system
        - All other components of the system
    - Explain benefits and draw backs to the system
    - Demonstrate set up and instructor or student launch
- Launch bungee guidance stand (if applicable)
    - Explain the hand launch bungee system
    - Explain the added guidance system and all of its components
    - The advantage of the guidance system
    - Demonstrate set up and instructor launch
- Hand launch (if applicable)
    - Goal of hand launching
    - Benefits and drawbacks
    - Different techniques
        - For both the hand launcher and pilot controlling UAS
- Catapult (if applicable)
    - Different types of catapult systems
    - Advantages and disadvantages
    - Demonstrate set up and instructor launch

4.6.7 Initial flight familiarity

- Flight to safe altitude
- Allow for student to experience different control inputs
    - Control inputs effecting pitch
    - Control inputs effecting roll
    - Control inputs effecting yaw
- Review/show controller features and displays (if applicable)

4.6.8 Introductory flight maneuvers

- Flying the box pattern
  - Flight box pattern with reference to ground
    - Suitable selection of box for visibility
  - Emphasize smoothness of controls
  - Emphasize traffic pattern and fixed wing visibility
  - Describe control lag vs system response
  - Describe loss of lift with turning
  - Describe safe altitude
  - Attempt to hold consistent pattern
- Distance flight exercise
  - Flight away from typical airport pattern
  - Fly out to considerable distance but maintain orientation
  - Preform 180 degree turn and fly back towards original position
  - Flying straight both directions only preform simple corrective maneuvers with minor control inputs avoiding drastic control movements in the region of reverse command
- Slow flight
  - At suitable altitude
  - Reduce speed of flight at lower controllable airspeed
  - Introduce effects of flaps (if applicable)
  - Introduce effects of gear (if applicable)
  - Preform shallow turns during slow flight

4.6.9 Complex flight maneuvers

- Circle over a point
  - Emphasize smoothness of combined controls
  - Varying controls based on direction of aircraft
  - Attempt to hold constant radius excepting changes in bank
  - Note changes in controls at different points along circle
- Power off stalls
  - At suitable altitude
  - Enter stall from slow flight
  - Focus on coordination
  - AOA awareness
  - Recovery technique
- Power on stalls
  - At suitable altitude
  - Technique to enter power on stall
  - Factors causing issues with coordination
  - Effects of power use during stall
  - AOA awareness
  - Turning tendencies
  - Recovery technique
- Steep turn figure eights
  - At suitable altitude
  - Desired entry speed

    - Increase bank while coordinated
    - Control feel under g loading
    - Overturning tendencies
    - Changing of rolling control

4.6.10 Autopilot operations (if appliable)

4.6.11 Landing

- Normal Landing
    - Describe typical landing procedure
    - Landing briefing
    - Pattern wok
    - Flying at appropriate and safe altitude
    - Flying appropriate and safe pattern size
    - Determining landing zone
    - Clearing the area
    - Approach speed
    - Landing configuration
    - Stabilized approach
    - Wind correction
    - Flare
- Soft or Off Field Landing
    - Difference when compared to normal landing
        - Speed
        - Flare
        - Touchdown zone aiming point
        - Change in landing distance
- Go around procedures

4.6.12 Emergency procedures

- Lost orientation and unusual attitude exercise
    - Instructor puts aircraft in unusual attitude
    - Student uses feel of controls to determine orientation and recover
    - Teach smooth control inputs and avoid over g situations
- Lost link
    - Describe possible situation
        - Autopilot and common reversions if applicable
        - Relate responses from student to preflight preparation if autopilot recovers controls
- Low fuel or battery scenario
    - Describe scenario requiring emergency landing
    - Have student demonstrate controlled return flight
        - As fast as safe and practical
        - Goals in doing this
- Engine out landings
    - Picking suitable landing areas
    - Best glide speed
    - Energy management

        - UAS features to reduce impact or damage by landing at slowest possible speed

4.6.13 After landing

- Fixed wing engine shut down
    - Battery change or refuel sequence
- Controller shut down
- Cleaning procedures
- Fixed wing aircraft disassembly
- Post flight damage check
- Checklist usage
- Post flight briefing
- Logbook

Chapter 5. Specific Training Curriculum: Helicopter

5.1 Helicopter Definition

5.1.1 Definition

5.2 Helicopter Uses

5.2.1 Typical uses/missions

5.2.2 Risk associated with missions

5.2.3 Training type flying

5.3 Helicopter Characteristics

5.3.1 General characteristics

5.3.2 Common helicopter components

- Motor
- Clutch
- Main rotor
- Tail rotor
- Swash plat
- Common connections and linkages
- Skids
- Controls: collective and cyclic

5.3.3. Collective stick movement

5.3.4 UAS axis

5.3.5 Gyroscopic effects

- Gyroscopic precession

5.3.6 Maneuverability

- Concepts for varying pitch, yaw, and roll
- Motor effects to get desired control maneuverability output

5.3.7 Typical helicopter flight patterns

5.3.8 Differences from other UAS types

5.3.9 New flight characteristics compared to previously flown UAS

5.3.10 Additional helicopter principals

5.4 Remote Control basics

5.4.1 Review of concepts and any changes with new UAS category

5.5 Introduce the Helicopter

5.5.1 Introduce the helicopter used for training

5.5.2 Show storage techniques

- LiPo storage (if applicable)
- Motor procedures
- Blade storage disassembly
- Helicopter Disassembly
- Lubrication of specific parts

5.5.3 Demonstrate assembly

5.5.4 Describe and show unique systems

5.5.5 Review checklist

5.6 Helicopter Training flight

5.6.1 Prior to arrival

- Describe training flight objectives
- Check and review NOTAM with student (if applicable)
- Confirm charged battery(s) and or correct fuel amount
- Confirm all UAS components present and ready to transport

5.6.2 Preflight preparation

- Checklist usage
  - Explain reason behind important checklist steps
  - Define unfamiliar components
- Common helicopter preflight check components
- Controller start up and or boot sequence
- Buddy box connection and test (if applicable)
- Controller controls
  - Control review and hands on demonstration
    - movement of blades
  - Left stick
    - Collective pitch
    - Rudder
  - Right stick
    - Cyclic controls – elevator
    - Cyclic controls – ailerons
- Orientation discussion
  - “Flying the nose” vs “flying the tail”
  - Axes review

5.6.3 Initial crew briefing

- Describe flight maneuvers
- Denote safest area to fly
- Denote typical pattern
- List possible safety hazards

- Formulate plan of action for any foreseeable emergencies
- Confirm loss of control procedures and instructor take over actions
    - Positive exchange of controls
- Demonstrate summarized crew briefing

5.6.4 Engine start

- Review and demonstrate typical engine start
- Startup switches
        - Throttle settings

5.6.5 Takeoff

- Normal take off
    - Observe helicopter squat or “floating”
    - Unnecessary lift of rudder rotation

5.6.6 Initial flight familiarity

- Observe effects of controls inputs during low run speed before rotation (Only do this if there are safety mounts on the helicopter and it won’t roll over or tip when doing this)
- With instructor supervision at safe altitude allow student to get familiar with control inputs and helicopter effects
    - General control inputs and effects should be achieved before maneuvers or hover lessons start

5.6.7 Introductory flight maneuvers

- Collective free hover
    - Stationary hover requiring subtitle but frequent cyclic movement
    - Relocate hover to different location with cyclic controls
        - Addition of collective pitch with greater cyclic inputs
- Orientation based collective free hover
    - Side hover
        - Right
        - Left
    - Nose in hover
        - Region of reverse command
        - Collective free method of hovering
- Collective change hover
    - Change hover with collective and cyclic

5.6.8 Complex flight maneuvers

- Spinning hover
    - Constant rudder input
- Rapid deceleration or quick stop maneuver

5.6.9 Landing

- Normal landing
- High wind landing discussion

5.6.10 Emergency procedures

- Straight in autorotation

- 180-degree autorotation
- Dynamic rollover discussion
- Unusual attitude

5.6.11 After landing

- Engine shut down
    - Battery change or refuel sequence
- Controller shut down
- Cleaning procedures
- Rotor disassembly
- Post flight damage check
- Checklist usage
- Post flight briefing
- Logbook

Chapter 6. Specific Training Curriculum: Airship

6.1 Airship Definition

6.1.1 Definition

6.2 Airship Uses

6.2.1 Typical uses/missions

6.2.2 Risk associated with airships and related missions

6.2.3 Training type flying

6.3 Airship Characteristics

6.3.1 General characteristics

6.3.2 Common airship components (background and how they work)

- Airship types structure and material
  - Ridged
  - Non-ridged
- Envelope material
- Structure (if applicable)
- Lifting gas
- Ballonet system (if applicable)
- Propulsion system
- Gondola (if applicable)

6.3.3 Theory

- Buoyancy

6.3.4 UAS axis

6.3.5 Maneuverability

- Concepts for varying pitch, yaw, and roll

6.3.6 new flight characteristics compared to previously flown UAS

6.4 Remote Control Basics

6.4.1 Review of concepts and any changes with new UAS category

6.5 Introduce the Training Airship

6.5.1 Introduce the airship used for training

6.5.2 Show storage techniques

- Gas removal
- Propulsion system shutdown
- Transporting techniques

6.5.3 Demonstrate UAS assembly

- Gas filling
    - Proper inflation technique
        - Lifting gas
        - Ballonet system (if applicable)
        - Measuring and setting correct amount
- Suspension cables (if applicable)
- Flight control surfaces
- Release valves

6.5.4 Describe and show unique UAS airship specific systems

6.5.5 Review checklists

6.6 Airship Training Flight

6.6.1 Prior to arrival

- Describe training flight objectives
- Check and review NOTAM with student if applicable
    - 24hrs in advance file backup NOTAM
- Confirm charged battery(s), fuel, and or available lifting gas
- Confirm all UAS components available which are required for flight

6.6,2 Preflight preparation

- Checklist usage
    - Explain reason behind important checklist steps
    - Define unfamiliar components
- Controller boot
- FPV connection (if applicable)
- Camera controls (if applicable)
- Controller and UAS control check
- Controller control movement and switch check and familiarity
- Emergency buttons and switches
- Airship lifting gas pressure and amount
    - Filling
- Vents test and check
- Ballonets check (if applicable)
- Gondola and suspension cables check (if applicable)

6.6.3 Initial crew briefing

- Describe flight maneuvers
- Denote safest area to fly
- List possible safety hazards
- Formulate plan of action for any foreseeable emergencies
- Demonstrate summarized crew briefing

6.6.4 Normal takeoff

- Describe airship takeoff sequence

- Reiterate takeoff technique
- Review checklist
- Commence student or instructor take off

6.6.5 Initial flight familiarity

- Allow for student to experience different control inputs
  - Control inputs effecting pitch
  - Control inputs effecting roll (if applicable)
  - Control inputs effecting yaw
- Review/show controller features and displays

6.6.6 Introductory flight maneuvers

- Ascents
  - Ascents with propulsion power
  - Ascents with lifting gas variation
    - Vents
    - Ballonets
- Altitude control
  - Ability to hold altitude
- Descents
  - Descents with propulsion power
  - Descents with lifting gas variation
    - Vents
    - Ballonets
- Box pattern
  - Controllability with altitude, yaw, and propulsion
  - Ground tack and wind correction
    - Knowledge of wind effects on flying characteristics

6.6.7 Complex flight maneuvers

- Climbing 180-degree turn
  - Maximum performance maneuver
  - Standards
  - How to very pitch and yaw or bank to accomplish the maneuver
    - Combined control inputs constantly changing through maneuver
- Rapid ascents and descent
  - Situations requiring rapid ascent or descent
  - Typical procedure
  - Possible effects and added risk associated with the maneuver
  - Effects of atmospheric conditions on rapid ascents and descents
  - Material requirements and limitations on this maneuver
- Circle pattern
  - Constantly attitude changing maneuver
    - Aircraft control at different rates at different times
    - Region of reverse command

6.6.8 Normal landing

- Describe typical landing procedure
    - Landing briefing
    - Flying at safe altitude
    - Determining landing zone
    - Clearing the area
    - Decent profile
    - Wind considerations
    - Stable descent
    - Final landing stage: arresting the descent
    - Go around planning and execution

6.6.9 Emergency procedures

- Lost orientation exercise
    - Flight on limit of VLOS
    - Instructor maneuvers airship to induce disorientation
    - Upon student receiving the controls, must regain orientation
        - Teach knowledge of controls and effect on flight
- Lost link / fly away
    - Describe possible situation
        - Demonstrate if applicable
        - Relate responses from student to preflight preparation
- Low battery scenario
    - Describe scenario requiring emergency descent and landing
    - Have student demonstrate controlled return flight
        - As fast as safe and practical
        - Goals in doing this
    - Describe airships features for returning to home (if applicable)
- Lifting gas fuel leak

6.6.10 After landing

- Airship propulsion system shut down
    - Power change or refuel sequence
- Controller shut down
- Airship deflation
- Airship disassembly
- Checklist usage
- Post flight briefing
- Logbook
- Allocate time for student questions

Chapter 7. Specific Training Curriculum: Visual Observers (VO)

7.1 VO Training Overview

7.1.1 Purpose

- COA Requirements
- Understanding VO responsibilities
- UAS safety

7.1.2 Training Overview

- Ground training
- Application “flying” training
- Training briefing
- Questions

7.2 Ground Training

7.2.1 Privileges and limitations

- Review FOM for all VO relevant regulations
    - Requirements to act as certified VO
    - VOs responsibility and importance as required crew member assisting with UCB COA flight operations
    - Right of way hierarchy
    - Safety and compliance
    - VOs ability to file SARs
- Review COA to show applicant the VOs duties
    - What must be done to satisfy VO requirement for different UAS operations
    - VO and PIC location
    - VO night training requirement

7.2.2 Practical knowledge

- Different Types of UAS Operations
- Common flying areas
- UAS Environmental Factors
- VO Environmental Factors
- Typical environmental conflicts
- Determining max VLOS distance
- Communication between VO and PIC
    - Typical standard reports from VOs to PICs
    - Briefings
        - PIC specific requests from VOs
    - Typical direction reporting references (12 hour clock)
    - How to work as an effective, nondistracting, crewmember

7.3 Flight Training

7.3.1 Active training

- Take responsibility as VO and preform the required actions
- Partake in real preflight briefings
- While UAS is flying practice ability to effectively and correctly communicate any potential conflicts
  - Know, understand, and communicate with correct terminology
  - Learn to assess situations with which require PIC response or PIC notification and which reportable situations which would be unnecessary or distracting

Chapter 8. Training Curriculum: CFIs

8.1 Overview

8.1.1 Description

- This training curriculum section is structured to provide applicants an outline on the CFI training process. This general outline clearly defines all desired training areas in title and bullet point format. This manual does not provide detailed information, as its intent is to just outline the training topics.

8.1.2 General CFI Privileges and Limitations

- Gain familiarity with the CFI relevant FOM chapters
- Unwritten UCB "civil" duty to provide excellent instruction
- Responsibilities and required CFI duties for the following sections:
  - Conducting initial PIC ground training events (excluding ground school)
  - Conducting initial PIC flight training events
  - Conducting UAS night training
  - Conducting On-Campus flight training
  - Conducting recurrency events for pilots
  - Conducting and signing off biannual flight reviews
  - Evaluating trainee in preparation for checkride

8.2 Ground Training

8.2.1 Enhanced Knowledge and Review of Initial PIC Ground School

- CFI authority and limitations on teaching initial ground school
- Develop instructional knowledge on all topics found in FOTM chapter 2
- Review and develop instructional knowledge on all documents found in the "ground school folder"
  - FOM
  - An introductory Guide to Airspace and Use of a Sectional Chart
  - List of recommended UAS Websites
  - COA Flight Checklist
  - Current Blanket COA
  - How to Read a METAR
  - Sectional Chart Legend
  - "Lawrence" Letter
  - Basic Airspace Guide
  - CU: Introduction to Export Controls
  - Export Control Regulations and UAS Research Frequently Asked Questions
  - ORM
  - Training Record Table

8.2.2 Teaching Ability

- Understand the basic “Fundamentals of Instruction”
  - Understanding the student learning process
    - What a student needs in order for effective learning to occur
  - Effective communication
  - The teaching processes
  - Teaching methods
  - How to give instructor critics
  - Evaluation
- Lesson plan and structure
  - Gain knowledge on typical formatting of a lesson plan
    - Overviews
    - Definitions
    - “Attention grabbers”
    - Time requirements

8.2.3 UCB CFI Specifics

- Training folder knowledge
- Online documents and spreadsheets
- Logbook entries
  - Proper sign off training and knowledge
- Skillsoft access
- Google drive access

8.2.4 Scenario Based Training

- Supervised CFI lesson between CFI applicant and real or simulated student
  - CFI focus on students learning and understanding
  - CFI ability to have clear, effective communication toward student
  - CFI ability to modify teaching method or explanation for a student unable to previously grasp concepts of the topic
- Ability to find information and use resources to answer questions which the CFI is initially unsure about

8.3 Flight Training

8.3.1 Flight Skills

- Training in order to have mastery of category specific ACS maneuvers
- Learn multitasking: train, practice, and experiment with teaching while flying
- Understand and explain common errors when flying and have ability to demonstrate both the common errors and the correct method
- Learn to describe flight actions and control inputs in a clear informative way
- Gain knowledge on when instructor intervention is necessary
  - Learn how to intervene and effectively gain control of flight controls
  - Learn how to recover the UAS from undesirable or dangerous flight attitude

- Learn to give training briefings
    - Ability to prebriefed flight maneuvers and standards
    - Ability to remember or list possible topics for discussion based on students actions which would be beneficial to student learning in post flight briefing

Chapter 9. Training Curriculum: Examiners

9.1 Overview

9.1.1 Description

- This training curriculum section is structured to provide applicants an outline on the examiners training process. This general outline clearly defines all training areas in title and bullet point format. This manual does not provide detailed information, as its intent is to just outline the training topics.

9.1.2 General Examiner Privileges and Limitations

- Gain familiarity with examiner relevant FOM chapters
- Responsibilities
  - Teach initial PIC ground school
  - Administer checkrides (both oral and flight portion) and issue PIC/VO certification based on the trainee's competency during the checkride
  - Strive to be the example of safety and responsibility for all UCB flight operation by upholding professional standards
  - Learn how to answer and where to find correct information to answer all UCB fight operations questions

9.2 Ground Knowledge

9.2.1 UCB Examiner specific knowledge

- Training folder knowledge
- Examiner sign offs and training folder logging
- Logbook entries
- Prerequisites and standards for different certificates
- Skillsoft admin access
- Google drive access

9.2.2 Ground knowledge

- Gain teaching knowledge on all ground school topics
- Learn and know the operation of UCB flight operations department well
- Develop ability to answer non common obscure questions by reference to all material

9.2.3 Evaluation ability

- Evaluation standards
  - Knowledge based
    - Complete, correct, and concise language and rational
    - Ability to evaluate applicant's knowledge on where to find unknown information
  - Personality based

- How to determine applicant’s mindset or personality type
  -Risk taker, macho, anti-authority, etc
  -Ability to detect good ADM in applicant
  -Present realistic scenarios to get confirmation
  on applicants’ personality

9.3 Flight Training

9.3.1 Flight Skills

- Training in order to have true and complete mastery of category specific ACS maneuvers
- Develop an examiner thought process system on how to rationally evaluate all ACS maneuvers.
- Gain knowledge on when evaluator intervention is necessary
- Develop understanding of common errors to have more insight on how to better evaluate applicants.
- Gain knowledge on specific UAS category quirks as to have knowledge on fair and equality when evaluating
- Understand effects of environment while flying as to be as fair and equal when evaluating

Chapter 10. Training Curriculum: Night

10.1 Night Training Overview

10.1.1 Purpose

10.1.2 Definition

10.1.3 Certification and training requirements

10.1.4 Training Overview

10.2 Background and Requirements

10.2.1 Background

- Previous and typical night training process
    - Power point slides

10.2.2 FAA night flight requirements

- Night definition
- UAS lighting requirements

10.2.3 Night vision physiology and terminology

- Any new or nonstandard language and terms

10.3 Eye Structure and Health

10.3.1 Human Eye

- 20/20 vision explained
    - Explain 20/20 corrective vision
    - Provide information on legal variations of eyesight requirements
- Human eye anatomy basics
    - Visual acuity
        - Pupil
        - Cornea
    - Eye inner structure
        - Rods
        - Cones

10.3.2 Night Vision

- Adaptation
    - Typical time requirements
    - What physically happens with eye to cause adaptation

10.4 Night Induced Illusions

10.4.1 Visual Illusions

- Relative-motion illusion
- Reversible perception illusion
- Flicker vertigo

10.5 Known Night Deficiencies

10.5.1 Night Myopia

- Description and example

10.5.2 Hyperopia

10.5.3 Astigmatism

- Picture example

10.5.4 Presbyopia

- Description and example

10.5.5 Dynamic Acuity

10.5.6 Recovery From Glare

10.5.7 Function Under Low Illumination

10.5.8 Information processing

10.5.9 Vision In Flight

- UAS light intensity
- Environmental lighting interference

10.6 Flight Monitoring Methods

10.6.1 Preflight

- Light illumination check
- Night currency
- Additional night training for crew
- VO additional required training

10.6.2 Collision Avoidance and Night Scanning

- VO techniques
- PIC techniques
- Differences between daylight procedures

10.6.3 Obstruction detection

- Object and structure lighting
- Chart references

10.6.4 Aircraft lighting

- COA requirements
- Different types of lighting
- Examples of aircraft lighting

10.6.5 Flight Familiarity

- Orientation exercises

10.6.6 Additional systems and testing

- Autopilot setup, payload, system setup or testing done during day before night operations

10.6.7 Logbooks and currency

- Logging night flights

- Night currency

10.7 Night Training Summary

Chapter 11. Training Curriculum: On Campus Flying

11.1 On Campus Flying Training Overview

11.1.1 Purpose

- Safety concerns
- Risk mitigation
- Additional controlling agencies
- Understanding of overall process

11.1.2 Training Overview

- Ground training
  - Regulations
  - Safety concerns
  - Operational procedures
- Flight training
  - None required
    - Proficient pilot skills needed so additional training is encouraged

11.2 Specific Training

11.2.1 Ground Training

- Regulations
  - Familiarity with relevant FOM rules and regulations
    - (FOM Section 2.27, 5.2, 7.6)
  - Familiarity with CU rules and regulations
    - (FOM Section 2.5)
  - Familiarity with CUPD rules and regulations
    - (FOM Section 2.49)
- Safety concerns
  - Flights near buildings and structures
    - Privacy and 200ft distance from residential halls regulation
    - Wind
      - -Wind flow around structures
    - Visual illusions
      - -Illusions and visibility limitations when flying with close backgrounds
  - Compact landing zones
    - Bystanders
    - Vegetation
    - Structures
  - Environment
    - Different environment considerations and talking points
    - Distractions
    - VO briefing considerations with regards to environment
- Operational procedures

- Contacts
- Requests and submissions
- Timelines and scheduling
- Flight Logistics
- Common flight paths over buildings and structures to avoid additional risk

11.2.2 Flight Training

- Proficiency
  - Understand specific UAS systems
  - Understand unique UAS flight characteristics
  - Precision
  - Fly maneuvers to tighter than typically acceptable tolerances

Chapter 12. Training Curriculum: Student Projects

12.1 Training Overview

12.1.1 Purpose

12.1.2 Outline

12.2 Relevant Documents

12.2.1 FOM

- Hobbyist and student applicability sections

12.2.2 Airworthiness Manual

- Sections which pertain to student built UAS

12.2.3 Risk Matrix

- Understanding different operational elements that affect risk

12.2.4 ORM

- Understanding different operational elements that affect risk

12.2.5 Ground School Training Documents

- Availability to access additional documents which may be applicable to aid to increase safety of the student project

12.3 Additional Resources and Contacts

12.3.1 Flight Operations Contacts

- DO
- CFIs

12.3.2 Airworthiness Evaluation Visits

12.3.3 AMA Safety Codes

12.4 Modified Ground School

12.4.1 FAA UAS Regulations and Procedures

- Part 107 specifics
- Hobbyist specifics

12.4.2 UCB UAS Practices

- Relevant FOM sections
- Student project history and common procedures

12.4.2 UCB UAS Regulations

12.4.3 General Hobbyist Rules

- AMA guidelines

12.4.4 Airspace

- Uncontrolled vs Controlled
- Legal flight areas

- Altitudes
- SUA ~ TFRs
- How to check if flight can be made legally

12.4.5 Weather

- Safe weather for UAS flying
- Where to obtain weather
- UAS weather limitations

12.4.6 Safe Flight Locations for Testing

- Local areas for safe operations
- Local laws for UAS flying
- Recommendations for flights in more unfamiliar areas

12.4.7 Operational Flight Considerations

- Safety
- VLOS
- Right of way rules
- UAS loading
  - Payloads
- Testing
- Adverse weather condition effects
- Daytime and nighttime operation
  - Night regulations, considerations, and practices if applicable

12.5 UAS and Mission Consulting

12.5.1 UAS Consulting

- Initial airworthiness evaluation
- Feasibility
- Payload considerations
- Foreseeable risks
- Recommendations

12.5.2 Mission Consulting

- Review of operational plan
- Feasibility
- Legality concerns
- Foreseeable risks
  - Risk matrix and ORM
- Recommendations
- Questions

Chapter 13. Training Curriculum: New COA

13.1 New COA Training Overview

13.1.1 Purpose

- Previous for additional training when planning to operate under new COA

13.1.2 Certification and Training Requirements

13.1.3 Training Overview

13.2 New COA General Discussion

13.2.1 Background

- Original COA issuance request

13.2.2 Operational considerations

- Possible uses
- General UAS specifics

13.3 New COA Specifics

13.3.1 General

- COA ID
- Page numbers
- Issuance
- Address
- FAR Part

13.3.2 Operations Authorized

- What is the general purpose of the COA
  - Does the COA fit the needs to the new applicant UAS flying request
- Differences from Blanket COA
- Any waived regulations

13.3.3 Standard Provisions

- Any new revision knowledge eliminating old written regulations (comply with "part hereof" statement)
- Differences from Blanket COA
- Waiver of any federal or state rules, laws, or regulations

13.3.4 Special Provisions

- General
  - Read and review
  - Understand the applicability of the general provisions
  - State any differences from these provisions and the provisions stated under the Blanket COA Special Provisions General Section
- Operations
  - Read and review
  - Understand the applicability of operations
    - UAS requirements
    - PIC requirements

            - Weather requirements
                - Visibility requirements
            - Environmental requirements
            - Operational procedures and requirements
                - Crew regulations
                - Contacts
            - State any differences from this operations section and the operations section stated under the Blanket COA
- NOTAMs
    - Submission requirements
    - New COA IDs
    - State any other differences from these NOTAM requirements and the NOTAM requirements which are used under the Blanket COA
- Reporting Requirements
    - Importance to PIC
    - State any other differences from these reporting requirements and the reporting requirements which are used under the Blanket COA
- sUAS Night Operations
    - Increased risk of night operations
    - Night regulations which would pertain to students mission
    - State any other differences from these night requirements and the night requirements which are used under the Blanket COA
- Special Use Airspace
    - New regulations
    - Coordination and deconflicting plan
        - Assigned personal to coordinate and deconflict during missions away from UCB
    - State any other differences from these SUA requirements and the SUA requirements which are used under the Blanket COA
- Flight Planning Requirements
    - Additional mission planning skills
    - Ability to comply while in the field or prior to mission
    - State any other differences from these reporting requirements and the reporting requirements which are used under the Blanket COA
- Emergency/Contingency Procedures
    - Importance to PIC
    - State any other differences from these reporting requirements and the reporting requirements which are used under the Blanket COA
- Any other Special Provisions not stated above
    - Importance to PIC
    - How these new special provisions will affect the mission
    - How these new special provisions affect risk
    - State any other differences from these reporting requirements and the reporting requirements which are used under the Blanket COA

13.4 New COA Training Summary

13.4.1 Overall COA summary
13.4.2 Questions
13.4.3 COA stipulations which effect the trainees desired mission
13.4.4 Risks associated with operating under new COA
13.4.5 Risk associated with planned mission under new COA

Chapter 14. Airman Certification Standards - Multirotor

14.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate being exercised in order to act as pilot in command (PIC) under this certificate. UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the aeronautical knowledge and flight proficiency standards pertaining to the certification of pilots flying multirotor category UAS. The certification for this chapter consists of a practical test or checkride in which the DO expects the evaluator to assess the applicant's mastery of the topic in accordance with the level of learning most appropriate for the specified task. This practical test consists of both a ground, sometimes referred to as oral, and flight portion. The ground portions main purpose is to test the applicant's mastery of topics in a discussion format while the flight portion is more tailored to applicant's flight proficiency operational considerations. The oral questioning may continue throughout the entire practical test.

The evaluator is required to test the applicant on all categories listed below during the oral and practical stages of the checkride being conducted for the approval of this certificate. For certification under a different difficulty level decrease, and therefore increase the difficulty, increase the originally stated tolerance by 20% for level 2 difficulty rated UAS and 40% for level 3 difficulty rated UAS. If a new maneuver is required for certification on a higher difficulty level UAS the task title will have a preceding asterisk after. Two asterisks will indicate a maneuver which is required for certification on a level two difficulty rated UAS. Three asterisks will denote a maneuver which is required for certification on a level three difficulty rated UAS. If no asterisks are present the maneuver is required for the basic level one difficulty rated UAS certification as well as for the level two and three difficulty rated UAS but with increased standards (with increased tolerances by 20 or 40 percent).

14.2 Preflight Preparation

14.2.1 Task A. Pilot Qualifications

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating themselves as PIC.
- References:
  1. FOM Sections: 2.2, 2.3.1, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.9, 2.7, 2.9, 3.1.3, 3.3.3
- Knowledge:
  1. Initial PIC requirements
  2. Flight currency

3. Privileges and limitations
4. Medical qualifications
5. Documents required to exercise privileges

- Risk management:
  1. Failure to distinguish between currency and proficiency.
  2. Inability to ensure fitness for flight.
  3. Failure to Identifying hazards when planning to act as PIC on unfamiliar UAS, environment, or using unfamiliar display or control systems.
- Skills:
  1. When evaluator presents example, applicant can determine requirements to act as PIC under the given flight rules and situational conditions.
  2. Applicant knows and can show evaluator the required documents which need to be on them and available when acting as PIC.
  3. PIC presents valid medical qualifications.
  4. Applicant understands PIC responsibilities.

14.2.2 Task B. UAS Airworthiness Requirements

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating the UAS intended for flight.
- References:
  1. FOM Sections: 2.4.1, 2.8, 4.2.2, 4.3, 9.1, 9.2, 9.3
  2. UAS Checklist
- Knowledge:
  1. UAS flight manual, marking, and placard requirements
  2. UAS ownership requirements
  3. Initial airworthiness
  4. Continuing airworthiness
  5. LIPO battery storage and use
  6. UAS discrepancies
  7. Aircraft Registration
- Risk management:
  1. Inoperative or nonairworthy equipment may be difficult to recognize and must be dealt with appropriately. This may be a new process for the applicant, so familiarity and practice are important for safety and risk mitigation.
  2. UAS abides by constantly changing FAA, COA, and FOM regulations regarding maintenance, placards, and airworthiness. Rules change over time and the applicant must be familiar with where to find new rules and regulations.
- Skills:
  1. Applicant can describe the UAS airworthiness, ownership, and registration information and process.
  2. In scenario given by the evaluator applicant can determine if the UAS is airworthy.

3. Applicant knows what checklist is appropriate to satisfy continuing airworthiness.
4. Applicant can explain continuing and initial airworthiness and their importance.

14.2.3 Task C. Weather

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating UAS weather requirements.
- References:
  1. FOM Sections: 2.6
  2. COA
  3. How To Read A MEATAR Document
  4. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Weather minimums
  2. Cloud clearance requirements
  3. METARs
  4. UAS ability and limitations on wind and weather
- Risk management:
  1. The difficulty in canceling flights due to weather with external pressures.
  2. Quickly changing weather and environment has drastic effects on safe operation.
  3. Added risks with flights in adverse or diminishing weather.
  4. METARs are new to most UCB Pilots and guessing meanings to unknown acronyms may cause added risk.
- Skills:
  1. Using the blanket COA weather minimums and standard cloud clearance requirements the applicant is able to determine if UAS flight is possible.
  2. Given a current METAR applicant has ability to accurately determine visibility and height of lowest ceiling.

14.2.4 Task D. National Airspace System, COA, and Flight Planning

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating in the national airspace system (NAS) under the current UCB blanket COA.
- References:
  1. FOM Sections: 2.4
  2. COA
  3. An Introductory Guide to Airspace and Use of a VFR Sectional Chart
- Knowledge:
  1. Types of airspace and associated requirements
  2. Chart symbology
  3. SUA
  4. TFR

5. Airport proximity
6. Sectional chart time reversions

- Risk management:
  1. Airspace may be new to applicant and guessing unknown airspace may lead to added risk and safety concerns.
  2. Various classes of airspace have different regulations, look similar, and can be difficult to decipher which could cause confusion to a new applicant.
- Skills:
  1. Applicant can determine the airspace in a certain location from a scenario given by the evaluator.
  2. Applicant understands airspace reversions and can correctly navigate the different websites and sources to find the correct information.
  3. Applicant can apply full COA flight procedures to determine if flight is possible in area.
  4. Applicant knows what crew is required to fly under COA and what constitutes a qualified crew.
  5. Applicant clearly understands safety is the great concern.

14.3 Preflight Procedures

14.3.1 Task A. NOTAM Submission

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with UAS NOTAM submission.
- References:
  1. FOM Sections: 2.4.2
  2. COA
  3. NOTAM Submission Guide
- Knowledge:
  1. Familiarity with filing database
  2. Location format: determination, size, documentation, and verification
  3. Valid time format: length and correct time zone
- Risk Management:
  1. Unfamiliarity with location designation submission format may cause improper submission thus providing unclear or unusable information.
  2. Inability to make realistic submissions could cause confusion to other NAS users.
- Skills:
  1. Applicant can file a NOTAM which accurately covers and corresponds to the location and time of proposed flight, which is consistent with all FOM, COA, and FAA regulations.

14.3.2 Task B. Preflight Assessment

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating the UAS as airworthy before flight.
- References:
    1. FOM Sections: 2.5.14, 2.8.3, 4.2.2, 4.3
    2. UAS Checklist
    3. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Pilot self-assessment
    2. UAS specific preflight actions
        - What items must be inspected
        - The reason for checking each item
        - How to detect possible defects
    3. Checklist usage
    4. Initial crew briefing
- Risk Management
    1. Inoperative or nonairworthy equipment may be difficult to recognize and must be dealt with appropriately. This may be a new process for the applicant, so familiarity and practice are important for safety and risk mitigation.
    2. Decision making to terminate the flight early or upon receipt of unairworthy information when external pressures exist may be difficult for the applicant.
- Skills:
    1. Applicant can inspect UAS with reference to appropriate checklist.
    2. Applicant can verify UAS is airworthy and in condition for safe flight.
    3. Applicant can give detailed and accurate crew briefing encompassing all important aspects of proposed flight.
    4. Applicant can prove all crew members are legal and safe to conduct the operation.

14.3.3 Task C. Engine Starting

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with recommended engine starting procedures.
- References:
    1. UAS Checklist
    2. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Normal engine start
    2. Safe locations for start
- Risk Management:
    1. Propeller safety at all times.
    2. Battery safety at all times.
- Skills:

1. Position UAS properly, considering structures, other UAS, wind, and safety of nearby persons and property.
2. Proper UAS engine start procedures.

14.4 Takeoff and Landings

14.4.1 Task A. Normal Takeoff and Climb

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal takeoff and climb procedures.
- References:
    1. FOM Sections: 2.5.8, 2.5.15
    2. UAS Checklist
    3. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Effects of atmospheric conditions on takeoff
    2. Appropriate power settings
    3. Minimum altitude safe altitude
- Risk Management:
    1. Selection of acceptable takeoff area and risks associated with it.
    2. Collision hazards, to include other UAS and obstacles during takeoff phase.
    3. Distractions, loss of directional control, improper task management during critical phase of flight.
    4. Assessment and avoidance of excessive control and ground induced instability.
- Skills:
    1. Ability to clear takeoff area.
    2. Lift off in stable and safe manner before initiating climb.
    3. Maintain directional control and proper wind drift correction throughout climb.
    4. Initial climb altitude is suitable for VLOS and safe from obstacles.

14.4.2 Task B. Normal Decent and Landing

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal decent and landing procedures.
- References:
    1. FOM Sections: 2.5.4, 2.5.15
    2. UAS Checklist
    3. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Effects of atmospheric conditions on landing
    2. Stabilized approaches
    3. Autoland or final stage landing procedures
    4. Landing briefing
- Risk Management:

1. Selecting suitable landing area and risks associated with it if not preplanned may be difficult.
2. Collision hazards, to include, other UAS and obstacles.
3. Distractions, loss of directional control, improper task management during critical phase of flight.

- Skills:
  1. Proper before landing briefing.
  2. Maintain safe altitude before final decent to LZ.
  3. Maintain directional control and proper wind drift correction throughout decent.
  4. Stable approach down to minimum hovering altitude right before touchdown.
  5. Correct controller inputs used to land UAS on ground.

14.5 Performance and Ground Reference Maneuvers

14.5.1 Task A. Box Pattern

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a flying the box pattern maneuver.
- References:
  1. FOTM Training Sections
- Knowledge:
  1. Control input and UAS response
  2. Power output changes with varying control inputs
  3. Orientation determination
  4. Wind effect on UAS and needed control to hold location
- Risk Management:
  1. Collision hazards, to include UAS, terrain, and obstacles. The area selected for this maneuver considers these factors.
- Skills:
  1. Clear the area.
  2. Select altitude sufficient for VLOS and obstacle avoidance.
  3. Fly even box pattern with reference to ground track. Each leg should be the same length to within 20 feet. Each centerline should be straight to within 20 degrees.
  4. Each turning corner is well defined.

14.5.2 Task B. Straight Transects

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with the straight transect flight maneuver.
- References:
  1. FOTM Training Sections
- Knowledge:
  1. Control input and UAS response
  2. Power output changes with varying control inputs

3. Wind effect on UAS and needed control to hold straight ground track
4. Change in control inputs when flying in a backwards

- Risk Management:
    1. Collision hazards, to include UAS, terrain, and obstacles.
- Skills:
    1. Clear the area.
    2. Select altitude sufficient for VLOS and obstacle avoidance.
    3. Fly to predetermined point within 30 feet without reference to any instruments or displays.
    4. Then fly backward, with forward facing orientation to original starting point within 20 feet without reference to any instruments or displays.
    5. Ability to hold a flight path along the center line of the transect to within +/-15 feet either side.

14.5.3 Task C. Circles Around a Point

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with turns around a point.
- References:
    1. FOTM Training Sections
- Knowledge:
    1. Control input and UAS response
    2. Power output changes with varying control inputs
    3. Flying in the region of reverse command
- Risk Management:
    1. Collision hazards, to include UAS, terrain, and obstacles.
    2. Effects of quick reactions when UAS is in “region of reverse command”.
- Skills:
    1. Clear the area.
    2. Select altitude sufficient for VLOS and obstacle avoidance.
    3. Select suitable ground reference area for maneuver.
    4. Complete one 360-degree orbiting turn around a prespecified point with the longitudinal axis of the UAS pointing towards the center point for the entirety of the turn.
    5. Radius of turn is prespecified and held within +/- 30 feet.

14.6 Emergency Operations

14.6.1 Task A. Loss of Orientation

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a UAS loss of orientation scenario.
- References:
    1. FOTM Training Section
- Knowledge:

1. VLOS rules and regulations
2. Control inputs effect on UAS movement
3. Autolevel and inherent stability of UAS

- Risk Management:
    1. Altitude awareness at extended distances.
    2. Effects of quick reactions when UAS is in "region of reverse command" or in an unknown orientation.
- Skills:
    1. Ability to determine orientation and return UAS into VLOS in timely manner.

14.6.2 Task B. Lost Link Scenario

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a possible lost link scenario while flying the UAS.
- References:
    1. FOTM Training Sections
    2. UAS Checklist
- Knowledge:
    1. Preflight preparation on the variety of hazards in the flight area with a possibility of effecting that UAS flight
    2. Actions available to recapture a lost link signal
    3. UAS range and flight time
    4. Controller and UAS emergency switches
- Risk Management:
    1. Known risks in and around flight area.
    2. Inappropriate or nonstandard actions may cause added unnecessary confusion and panic.
- Skills:
    1. Applicant can determine appropriate actions to take during a simulated lost link scenario including knowledge of required information to communicate to nearest airport or possible at-risk facility if applicable.
    2. Applicant has knowledge of emergency procedures and attempts to take appropriate actions in the interest of safety.

14.6.3 Task C. Low Fuel / Low Battery

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a low fuel or low battery emergency while flying the UAS.
- References:
    1. UAS Checklist
- Knowledge:
    1. UAS battery and fuel limitations
    2. UAS response to low fuel or battery situation
    3. Possible actions to extend UAS fuel life
- Risk Management:

1. Added risk with aggressive control inputs and flying faster when trying to execute a quick simulated emergency maneuvers or landings.

- Skills:
    1. Determine suitable landing area.
    2. Complete emergency checklist or memory items.
    3. Get in a position to make an emergency or precautionary emergency landing in a timely manner.

14.6.4 Task D. Emergency Landing

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with an emergency landing.
- References:
    1. UAS Checklist
- Knowledge:
    1. Immediate action items and emergency procedures
    2. Landing briefing
    3. Safe landing zone
    4. Safe altitude
    5. Situations that require an emergency landing
- Risk Management:
    1. Added risk with aggressive control inputs and flying faster when trying to execute quick simulated emergency maneuvers or landings.
    2. The original landing zone may pose more hazards then desired and a new landing zone should be selected.
- Skills:
    1. Determine if UAS has ability to safely land in planned LZ.
    2. Execute stabilized but timely emergency approach and landing.
    3. Complete emergency checklist or memory items.

14.7 Shutdown and Securing UAS

14.7.1 Task A. Shutdown and Securing UAS

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with shut down and securing operations for the UAS.
- References:
    1. FOM Sections: 2.9.2, 2.9.3, 2.5.14
    2. UAS Checklist
- Knowledge:
    1. UAS shutdown, securing, and postflight inspection
    2. UAS disassembly and storage procedures
    3. UAS required documentation
    4. Required logbook entries
- Risk Management:
    1. Inappropriate activities and distractions pose added risk.

2. PIC professional and proper decision making until completion of *entire* flight.
3. Towards end of flight it is crucial to avoid rushing and unsafe practices.

- Skills:
  1. Complete appropriate checklist.
  2. Shutdown and power down of all applicable components.
  3. Proper disassemble and storage UAS.
  4. Correct and comprehensive post flight debrief.
  5. Correct and complete logbook entries.

Chapter 15. Airman Certification Standards – Fixed Wing

15.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate or rating being exercised in order to act as pilot in command (PIC). UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the aeronautical knowledge and flight proficiency standards pertaining to the certification of pilots flying fixed wing category UAS. The certification for this chapter consists of a practical test or checkride in which the DO expects the evaluator to assess the applicant's mastery of the topic in accordance with the level of learning most appropriate for the specified task. This practical test consists of both a ground, sometimes referred to as oral, and flight portion. The ground portions main purpose is to test the applicant's mastery of topics in a discussion format while the flight portion is more tailored to applicant's flight proficiency operational considerations. The oral question may continue throughout the entire practical test.

The evaluator is required to test the applicant on all categories listed below during the oral and practical stages of the checkride being conducted for the approval of this certificate. For certification under a different difficulty level decrease the originally stated tolerance by 20% for level 2 difficulty rated UAS and 40% for level 3 difficulty rated UAS. If a new maneuver is required for certification on a higher difficulty level UAS the task title will have asterisk after the title. Two asterisks will indicate a maneuver which is required for certification on a level two difficulty rated UAS. Three asterisks will denote a maneuver which is required for certification on a level three difficulty rated UAS. If no asterisks are present the maneuver is required for the basic level one difficulty rated UAS certification as well as for the level two and three difficulty rated UAS but with reduced standards (20 or 40 percent).

15.2 Preflight Preparation

15.2.1 Task A. Pilot Qualifications

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating themselves as PIC.
- References:
  1. FOM Sections: 2.2, 2.3.1, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.9, 2.7, 2.9, 3.1.3, 3.3.3
- Knowledge:
  1. Initial PIC requirements
  2. Flight currency
  3. Privileges and limitations
  4. Medical qualifications
  5. Documents required to exercise privileges
- Risk Management:
  1. Failure to distinguish between currency and proficiency.
  2. Failure to ensure fitness for flight.
  3. Failure to Identifying hazards when piloting unfamiliar UAS or using unfamiliar display or control systems.
- Skills:
  1. When evaluator presents example, applicant can determine requirements to act as PIC under the given flight rules and situational conditions.
  2. Applicant knows and can show evaluator the required documents which need to be on and available when acting as PIC.

15.2.2 Task B. UAS Airworthiness Requirements

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating the UAS type intended for flight.
- References:
  1. FOM Sections: 2.4.1, 2.8, 4.2.2, 4.3, 9.1, 9.2, 9.3
- Knowledge:
  1. UAS flight manual, marking, and placard requirements
  2. UAS ownership requirements
  3. Initial airworthiness
  4. Continuing airworthiness
  5. LIPO battery storage and use
  6. Aircraft discrepancies
  7. Aircraft registration
- Risk Management:
  1. Inoperative or nonairworthy equipment may be difficult to recognize and must be dealt with appropriately. This may be a new process for the applicant, so familiarity and practice are important for safety and risk mitigation.

2. UAS abides by constantly changing FAA, COA, and FOM regulations regarding maintenance, placards, and airworthiness. Rules change over time and the applicant is familiar with where to find new rules and regulations.

- Skills:
  1. Applicant can describe the UAS airworthiness and registration information and process.
  2. In scenario given by the evaluator applicant can determine if the UAS is airworthy.
  3. Applicant can explain continuing airworthiness and its importance.
  4. Applicant understands the differences between preflight procedures on different types of UAS.

15.2.3 Task C. Weather

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating UAS weather requirements.
- References:
  1. FOM Sections: 2.6
  2. COA
  3. How To Read A MEATAR
  4. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Weather minimums
  2. Cloud clearance requirements
  3. METAR
  4. UAS ability and limitations on wind and weather
  5. UAS new type weather related flight characteristics
- Risk management:
  1. The difficulty in canceling flights due to weather with external pressures .
  2. Quickly changing weather and environment has drastic effects on safe operation.
  3. Added risks with flights in adverse or diminishing weather.
  4. METARs are new to most UCB Pilots and guessing meanings to unknown acronyms may cause added risk.
- Skills:
  1. Using the blanket COA weather minimums and standard cloud clearance requirements the applicant is able to determine if UAS flight is possible.
  2. Given a current METAR applicant has ability to accurately determine location, visibility, height of lowest ceiling.

15.2.4 Task D. National Airspace System, COA, and Flight Planning

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating in the national airspace system (NAS) under the current UCB blanket COA.
- References:

1. FOM sections: 2.4
2. COA
3. An Introductory Guide to Airspace and Use of a VFR Sectional Chart

- Knowledge:
  1. Types of airspace and associated requirements
  2. Chart symbology
  3. SUA
  4. TFR
  5. Airport proximity
  6. Sectional chart time reversions
- Risk management:
  1. Airspace may be new to applicant and guessing unknown airspace may lead to added risk and safety concerns.
  2. Various classes of airspace have different regulations, look similar, and can be difficult to decipher which could cause confusion to a new applicant.
- Skills:
  1. Applicant can determine the airspace in a certain location from a scenario given by the evaluator.
  2. Applicant understands airspace reversions and can correctly navigate the different websites and sources to find the correct information.

15.2.5 Task E. Loading and Performance

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with the predicted outcome and performance based on UAS loading and environmental conditions.
- References:
  1. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. UAS weight limitations
  2. UAS balance limitations
  3. UAS performance
  4. Possible flight characteristics outside limitations
- Risk management:
  1. Fixed wing UAS typically require more understanding when considering loading and its effects on weight and balance.
- Skills:
  1. Calculating required weight and balance if applicable or appropriate actions if no weight and balance manufacture documents are published.
  2. Physically be able to determine aircraft balance points and determine if balance is safe for flight.

15.3 Preflight Procedures

15.3.1 Task A. NOTAM Submission

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with UAS NOTAM submission.
- References:
  1. FOM Sections: 2.4.2
  2. COA
  3. NOTAM Submission Guide
- Knowledge:
  1. Familiarity with filing database
  2. Location format: determination, size, documentation, and verification
  3. Valid time format: length and correct time zone
- Risk Management:
  1. Unfamiliarity with location designation submission format may cause improper submission thus providing unclear or unusable information.
  2. Inability to make realistic submissions could cause confusion to other NAS users.
- Skills:
  1. Applicant can file a NOTAM which accurately covers and corresponds to the location and time of proposed flight, which is consistent with all FOM, COA, and FAA regulations.

15.3.2 Task B. Preflight Assessment

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating the UAS as airworthy before flight.
- References:
  1. FOM Sections: 2.5.14, 2.8.3, 4.2.2, 4.3
  2. UAS Checklist
  3. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Pilot self-assessment
  2. UAS specific preflight actions
     - What items must be inspected
     - The reason for checking each item
     - How to detect possible defects
  3. Checklist usage
  4. Initial crew briefing
- Risk Management
  1. Inoperative or nonairworthy equipment may be difficult to recognize and must be dealt with appropriately. This may be a new process for the applicant, so familiarity and practice are important for safety and risk mitigation.

2. Decision making to terminate the flight early or upon receipt of unairworthy information when external pressures exist may be very difficult for a first-time applicant.
3. When moving to new UAS types it is important to note the differences between operations to avoid confusion and mistakes when preflighting the UAS.

- Skills:
  1. Applicant can inspect UAS with reference to appropriate checklist.
  2. Applicant can verify UAS is airworthy and in condition for safe flight.
  3. Applicant can give detailed and accurate crew briefing encompassing all important aspects of proposed flight.
  4. Applicant can prove all crew members are legal and safe to conduct the operation.

15.3.3 Task C. Engine Starting

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with recommended engine starting procedures.
- References:
  1. UAS Checklist
  2. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Normal engine start
  2. Safe locations for start (plane secured or pointed in safe direction incase throttle malfunction as fixed wing UAS tend to not have breaks)
- Risk Management:
  1. Propeller safety at all times.
  2. Battery safety at all times.
  3. Fixed wing UAS usually have wheels without breaks, securing the UAS before engine start is and new but critical task.
  4. Certain engines require a start with hands near the propeller, if this is the case, care and training should be taken to avoid a propeller related hand strike.
- Skills:
  1. Position UAS carefully considering structures, other UAS, wind, and safety of nearby persons and property.
  2. Proper UAS engine start procedures.

15.3.4 Task D. Engine Run Up

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with recommended UAS engine run up, tuning, and check.
- References:
  1. UAS Checklist
  2. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Proper engine performance during runup

2. Run up procedure

- Risk Management:
    1. Engine runup is a unique procedure which relies heavily on PICs ability to both feel and listen to thrust changes in order to determine if engine is running at a normal or optimum level. This procedure is new to many PICs and can be challenging so proper education and performance is important.
    2. For UAS with gas or glow engines requiring tuning special care should be taken to mitigate the risk of a hand-propeller strike.
- Skills:
    1. Deliberate and dedicated check effectively assessing UAS's engine and propeller performance throughout the check.
    2. (if applicable) The applicant can tune the engine to best performance or recommended power setting.

15.4 Takeoff and Landings

15.4.1 Task A. Normal Takeoff and Climb

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal takeoff and climb procedures.
- References:
    1. FOM Sections: 2.5.8, 2.5.15
    2. UAS Checklist
    3. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Effects of atmospheric conditions on takeoff
    2. Appropriate power settings
    3. Appropriate UAS configuration
- Risk Management:
    1. Selection of acceptable takeoff area and risks associated with it.
    2. Collision hazards, to include other UAS and obstacles during takeoff phase.
    3. Distractions, loss of directional control, improper task management during critical phase of flight.
    4. Fixed wing UAS may have different configurations required for takeoff which is new added complexity when compared to other UAS.
- Skills:
    1. Preform pretakeoff briefing.
    2. Ability to clear takeoff area.
    3. Position UAS on runway centerline or takeoff path.
    4. Apply complete takeoff power prior to rotation (if appliable).
    5. Maintain safe climb attitude to maintain safe and adequate climb speed.
    6. Maintain directional control and proper wind drift correction throughout roll out, takeoff, and climb.

7. Retract landing gear and flaps (if applicable) in accordance with UAS model type recommendations.
8. Complete the appropriate checklist.
9. Abort the takeoff if the criteria for a normal safe takeoff are not met.

15.4.2 Task B. Normal Decent and Landing

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal decent and landing procedures.
- References:
  1. FOM Sections: 2.5.4, 2.5.15
  2. UAS Checklist
  3. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Effects of atmospheric conditions on landing
  2. Stabilized approaches
  3. Appropriate UAS configuration
  4. Landing briefing
- Risk Management:
  1. Selecting suitable landing area and risks associated with it.
  2. Collision hazards, to include, other UAS and obstacles.
  3. Distractions, loss of directional control, improper task management during critical phase of flight.
  4. Added complexity of energy management concerning float or sink in relation to desired touch down point may cause additional risk to undershooting or overshooting desired landing point.
- Skills:
  1. Proper landing briefing.
  2. Consider wind conditions, landing surface, obstruction, and select proper runway or landing area.
  3. Ensure UAS is aligned with the correct runway or landing area.
  4. Ensure runway or landing area is clear.
  5. Establish appropriate approach, landing configuration, and airspeed. Adjust pitch and power to maintain stabilized approach.
  6. Make smooth, timely, and correct control inputs during round out and touchdown.
  7. Touch down at the suitable safe speed recommended by manufacture or predetermined by the pilot in a touchdown zone which is predetermined within a distance equal to 25 percent of the UAS's total landing distance but no less than the predetermined distance (-0ft).
  8. Execute a timely go around if the approach cannot be made within the tolerances specified above or for any other condition that may result in an unsafe approach or landing.

15.5 Performance and Ground Reference Maneuvers

15.5.1 Task A. Box Pattern

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with flying a box pattern.
- References:
    1. FOTM Training Sections
- Knowledge:
    1. Control input and UAS response
    2. Orientation determination
    3. Ground track
        - Wind effect producing UAS crab angle
        - Wind effect on UAS ground speed
    4. Comparison between horizontal and vertical components of lift in turns and required control inputs to hold altitude
- Risk Management:
    1. Collision hazards, to include UAS, terrain, and obstacles. The area selected for this maneuver considers these factors.
    2. Effects of quick or incorrect reactions when UAS is in “region of reverse command”.
- Skills:
    1. Clear the area
    2. Select altitude sufficient for VLOS and obstacle avoidance.
    3. Fly even box pattern with reference to ground track which resembles an box pattern with equal length legs.
    4. All leg distances are similar to within +/- 20ft.
    5. Altitude +/- 20ft.
    6. Bank not to exceed 60 degrees at steepest point.
    7. All leg ground tracks are held to +/- 30 degrees.

15.5.2 Task B. Straight Transects

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a straight transect flight.
- References:
    1. FOTM Training Sections
- Knowledge:
    1. Control input and UAS response
    2. Straight ground track
        - Wind effect on UAS to hold position
    3. Control inputs effecting the region of reverse command
- Risk Management:
    1. Collision hazards, to include UAS, terrain, and obstacles.
    2. Effects of quick or incorrect reactions when UAS is in “region of reverse command”.
- Skills:
    1. Clear the area.
    2. Select altitude sufficient for VLOS and obstacle avoidance.

3. Fly to predetermined point within 30ft without reference to instruments or video downlink.
4. Ability to complete 180 degree turn and fly UAS in opposite direction with correct control inputs.
5. Hold outbound and inbound headings within 20 degrees.
6. Hold altitude within 15ft.

15.5.3 Task C. Turns Around a Point

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with turns around a point.
- References:
  1. FOTM Training Sections
- Knowledge:
  1. Control input and UAS response
  2. Constant altitude turns
     - Effect on vertical lift required in a while turning
  3. Ground track
  4. Flying in the region of reverse command
- Risk Management:
  1. Collision hazards, to include UAS, terrain, and obstacles.
  2. Effects of quick or incorrect reactions when UAS is in “region of reverse command”.
- Skills:
  1. Clear the area.
  2. Select altitude sufficient for VLOS and obstacle avoidance.
  3. Select suitable ground reference area for maneuver.
  4. Complete one 360-degree orbiting turn around a predetermined ground point. The lateral axis of the UAS should point towards the center of the point throughout the maneuver.
  5. Radius of turn is prespecified and held within +/- 20 feet.
  6. Bank angle not to exceed 60 degrees.

15.5.4 Task D. Slow flight

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with slow flight.
- References:
  1. FOTM Training Section
- Knowledge:
  1. UAS airspeed effect on controllability
  2. Configuration effects on slow flight
  3. Turning effects when flying in slow flight
  4. Pitch and power relationship
- Risk Management:
  1. Inadvertent slow flight leading to stall.
  2. Failure to determine and maintain coordinated flight.
  3. Range and limitations on stall warning indicators could allow for an unexpected stall.
- Skills:

1. Select altitude sufficient for VLOS and traffic and obstacle avoidance.
2. Deploy flaps a gear to the levels determined by the manufacturer or pilot for slow flight.
3. Maintain consistent altitude when entering and exiting the maneuver.
4. Applicant has the ability to fly one traffic pattern circuit while maintaining slow flight configuration and airspeed.
5. Airspeed changes are minimal.
6. Altitude changes are held to within +/-15 feet.

15.5.5 Task E. Power Off Stalls

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with power off stalls.
- References:
    1. FOTM Training Section
- Knowledge:
    1. Aerodynamics associated with stalls which include relationship between angle of attack, airspeed, CG, load factor, power setting, and weight
    2. Factors and situations that could lead to an inadvertent power off stall
- Risk Management:
    1. Limitations on stall warning indicators.
    2. Inability to determine coordination and difficulty staying coordinated.
    3. Secondary stalls, accelerated stalls, and cross controlled stalls.
    4. Improper stall recovery procedure from non-intentional stall.
- Skills:
    1. Clear the area.
    2. Select safe altitude no lower than 30ft.
    3. Configure the UAS in landing or cruise configuration as specified by the evaluator.
    4. Maintain specified heading within 20 degrees of original heading.
    5. Acknowledge the cues of an impending stall.
    6. Bring UAS to full stall.
    7. Execute a stall recovery in accordance with procedures set forth by manufacturer or what is determined acceptable by training curriculum or evaluator, with minimum altitude loss.
    8. Retract the flaps and gear to the recommended settings (if applicable) and commence a climb out at safe altitude and airspeed.

15.5.6 Task E. Power On Stalls

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with power on stalls.
- References:
    1. FOTM Training Sections

- Knowledge:
    1. Aerodynamics associated with stalls which include relationship between angle of attack, airspeed, CG, load factor, power setting, and weight
    2. Factors and situations that could lead to an inadvertent power off stall.
- Risk Management:
    1. Range and limitations on stall warning indicators.
    2. Inability to determine coordination and difficulty staying coordinated.
    3. Secondary stalls, accelerated stalls, and cross controlled stalls.
    4. Effect of environmental elements on aircraft performance.
    5. Improper stall recovery procedure.
    6. Improper power setting resulting in an excessively out of control maneuver.
- Skills:
    1. Clear the area.
    2. Select safe altitude to finish maneuver no lower than 30ft AGL.
    3. Configure the UAS in takeoff configuration as specified by the evaluator.
    4. Maintain specified heading within 20 degrees of original heading.
    5. Apply power to the recommended power on stall power and pitch for an attitude which will attain power on stall.
    6. Acknowledge the cues of an impending stall.
    7. Execute a stall recovery in accordance with procedures set forth by manufacturer or what is determined acceptable by training curriculum.
    8. Retract the flaps and gear to the recommended settings and commence a climb out at safe altitude and airspeed.
    9. Throughout maneuver applicant has ability to use control inputs which counter the effects of stalling with power.

15.6 Emergency Operations

15.6.1 Task A. Unusual Attitudes and Orientation Determination

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a UAS unusual attitudes.
- References:
    1. FOTM Training Sections
- Knowledge:
    1. VLOS rules and regulations
    2. Control inputs effect on UAS movement
    3. Autolevel and inherent stability of UAS
- Risk Management:
    1. Effects of improper and drastic control inputs in unusual attitudes.
    2. Attitude awareness at extended distances.
- Skills:

1. Ability to determine orientation and recover UAS into level flight attitude in timely manner in location well within VLOS.
2. Ability to determine orientation and recover UAS into level flight attitude in timely manner at a distance on the boundary of VLOS.

15.6.2 Task B. Low Fuel / Low Battery / Engine Failure

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a low fuel or low battery emergency while flying the UAS.
- References:
  1. UAS Checklist
  2. FOTM Training Sections
- Knowledge:
  1. UAS battery and fuel limitations
  2. UAS response to low fuel or battery situation
  3. Possible actions to extend UAS battery life or fuel
- Risk Management:
  1. Added risk with aggressive control inputs and flying faster in order to make emergency landing.
  2. Some battery driven systems which draw substantial power and have potential to fail first or effect other systems.
- Skills:
  1. Determine suitable landing area.
  2. Preform actions to extend fuel or battery life.
  3. Establish best glide speed if engine failure occurs.
  4. Complete emergency checklist or memory items.
  5. Commence emergency landing.

15.6.3 Task C. Emergency Landing

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with an emergency landing.
- References:
  1. FOM
  2. UAS checklist
  3. FOTM Training Section
- Knowledge:
  1. Immediate action items and emergency procedures
  2. Landing briefing
  3. Safe landing zone
  4. Safe altitude
  5. Situations that require an emergency landing
  6. General airspeed which provides increase in distance over time
  7. Stabilized approach to include concepts of energy management
- Risk Management:
  1. Flight at low speed and trying to stretch glide to desired landing zone.
  2. Added risk with aggressive control inputs and flying faster in order to make emergency landing.

- Skills:
    1. Establish and maintain appropriate pitch attitude to maintain a speed suitable for the emergency landing to be conducted.
    2. Configure the UAS in accordance with manufactures recommendation and for existing circumstances.
    3. Establish suitable landing area considering altitude, wind, terrain, obstructions, and available distance.
    4. Prepare for a landing as specified by the evaluator.
    5. Execute an emergency landing in the safest way possible given the situation.
    6. Complete the appropriate checklist or memory items.

15.7 Shutdown and Securing UAS

15.7.1 Task A. Shut Down and Securing UAS

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a shut down and securing operations.
- References:
    1. FOM Sections: 2.9.2, 2.9.3, 2.5.14
    2. UAS Checklist
- Knowledge:
    1. UAS shutdown, securing, and postflight inspection
    2. UAS disassembly and storage procedures
    3. UAS required documentation
    4. Required logbook entries
- Risk Management:
    1. Inappropriate activities and distractions pose added risk.
    2. PIC professional and proper decision making until completion of *entire* flight.
    3. Towards end of flight it is crucial to avoid rushing and unsafe practices.
- Skills:
    1. Complete appropriate checklist.
    2. Shutdown and power down of all applicable components.
    3. Proper disassemble and storage UAS.
    4. Correct and comprehensive post flight debrief.
    5. Correct and complete logbook entries.

Chapter 16. Airman Certification Standards - Helicopter

16.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate being exercised in order to act as pilot in command (PIC) under this certificate. UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the aeronautical knowledge and flight proficiency standards pertaining to the certification of pilots flying helicopter category UAS. The certification for this chapter consists of a practical test or checkride in which the DO expects the evaluator to assess the applicant’s mastery of the topic in accordance with the level of learning most appropriate for the specified task. This practical test consists of both a ground, sometimes referred to as oral, and flight portion. The ground portions main purpose is to test the applicant’s mastery of topics in a discussion format while the flight portion is more tailored to applicant’s flight proficiency operational considerations. The oral questioning may continue throughout the entire practical test.

The evaluator is required to test the applicant on all categories listed below during the oral and practical stages of the checkride being conducted for the approval of this certificate. For certification under a different difficulty level decrease, and therefore increase the difficulty, the originally stated tolerance by 20% for level 2 difficulty rated UAS and 40% for level 3 difficulty rated UAS. If a new maneuver is required for certification on a higher difficulty level UAS the task title will have a preceding asterisk after. Two asterisks will indicate a maneuver which is required for certification on a level two difficulty rated UAS. Three asterisks will denote a maneuver which is required for certification on a level three difficulty rated UAS. If no asterisks are present the maneuver is required for the basic level one difficulty rated UAS certification as well as for the level two and three difficulty rated UAS but with increased standards (with increased tolerances by 20 or 40 percent).

16.2 Preflight Preparation

16.2.1 Task A. Pilot Qualifications

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating themselves as PIC.
- References:
    1. FOM Sections: 2.2, 2.3.1, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.9, 2.7, 2.9, 3.1.3, 3.3.3
- Knowledge:
    1. Initial PIC requirements
    2. Flight currency
    3. Privileges and limitations
    4. Medical qualifications
    5. Documents required to exercise privileges
- Risk Management:
    1. Failure to distinguish between currency and proficiency.
    2. Failure to ensure fitness for flight.
    3. Failure to Identifying hazards when piloting unfamiliar UAS or using unfamiliar display or control systems.
- Skills:
    1. When evaluator presents example, applicant can determine requirements to act as PIC under the given flight rules and situational conditions.
    2. Applicant knows and can show evaluator the required documents which need to be on and available when acting as PIC.

16.2.2 Task B. UAS Airworthiness Requirements

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating the UAS type intended for flight.
- References:
    1. FOM Sections: 2.4.1, 2.8, 4.2.2, 4.3, 9.1, 9.2, 9.3
    2. UAS Checklist
- Knowledge:
    1. UAS flight manual, marking, and placard requirements.
    2. UAS ownership requirements.
    3. Initial Airworthiness.
    4. Continuing Airworthiness.
    5. LIPO Battery Storage and Use.
    6. Aircraft Discrepancies.

7. Aircraft Registration.

- Risk Management:
    1. Inoperative or nonairworthy equipment may be difficult to recognize and must be dealt with appropriately. This may be a new process for the applicant, so familiarity and practice are important for safety and risk mitigation.
    2. UAS abides by constantly changing FAA, COA, and FOM regulations regarding maintenance, placards, and airworthiness. Rules change over time and the applicant is familiar with where to find new rules and regulations.
- Skills:
    1. Applicant can describe the UAS airworthiness and registration information and process.
    2. In scenario given by the evaluator applicant can determine if the UAS is airworthy.
    3. Applicant can explain continuing airworthiness and its importance.
    4. Applicant understands the differences between preflight procedures on different types of UAS.

16.2.3 Task C. Weather

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating UAS weather requirements.
- References:
    1. FOM Sections: 2.6
    2. COA
    3. How To Read A MEATAR
    4. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Weather minimums
    2. Cloud clearance requirements
    3. METAR
    4. UAS ability and limitations on wind and weather
    5. UAS new type weather related flight characteristics
- Risk management:
    1. The difficulty in canceling flights due to weather with external pressures.
    2. Quickly changing weather and environment has drastic effects on safe operation.
    3. Added risks with flights in adverse or diminishing weather.
    4. METARs are new to most UCB Pilots and guessing meanings to unknown acronyms may cause added risk.
- Skills:
    1. Using the blanket COA weather minimums and standard cloud clearance requirements the applicant is able to determine if UAS flight is possible.

2. Given a current METAR applicant has ability to accurately determine location, visibility, height of lowest ceiling.

16.2.4 Task D. National Airspace System, COA, and Flight Planning

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating in the national airspace system (NAS) under the current UCB blanket COA.
- References:
    1. FOM sections: 2.4
    2. COA
    3. An Introductory Guide to Airspace and Use of a VFR Sectional Chart
- Knowledge:
    1. Types of airspace and associated requirements
    2. Chart symbology
    3. SUA
    4. TFR
    5. Airport proximity
    6. Sectional chart time reversions
- Risk management:
    1. Applicant has familiarity with different UCB approved resources pertaining to airspace.
    2. Various classes of airspace have different regulations, look similar, and can be difficult to decipher which could cause confusion to a new applicant.
- Skills:
    1. Applicant can determine the airspace in a certain location from a scenario given by the evaluator.
    2. Applicant understands airspace reversions and can correctly navigate the different websites and sources to find the correct information.

16.3 Preflight Procedures

16.3.1 Task A. NOTAM Submission

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with UAS NOTAM submission.
- References:
    1. FOM Sections: 2.4.2
    2. COA
    3. NOTAM Submission Guide
- Knowledge:
    1. Familiarity with filing database
    2. Location format: determination, size, documentation, and verification
    3. Valid time format: length and correct time zone

- Risk Management:
  1. Unfamiliarity with location designation submission format thus providing unclear or unusable information.
  2. Inability to make realistic submissions could cause confusion to other NAS users.
- Skills:
  1. Applicant can file a NOTAM which accurately covers and corresponds to the location and time of proposed flight, which is consistent with all FOM, COA, and FAA regulations.

16.3.2 Task B. Preflight Assessment

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating the UAS as airworthy before flight.
- References:
  1. FOM Sections: 2.5.14, 2.8.3, 4.2.2, 4.3
  2. UAS Checklist
  3. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Pilot self-assessment
  2. UAS specific preflight actions
     - What items must be inspected
     - The reason for checking each item
     - How to detect possible defects
  3. Checklist usage
  4. Initial crew briefing
- Risk Management
  1. Inoperative or nonairworthy equipment may be difficult to recognize and must be dealt with appropriately. This may be a new process for the applicant, so familiarity and practice are important for safety and risk mitigation.
  2. Decision making to terminate the flight early or upon receipt of unairworthy information when external pressures exist may be very difficult for a first-time applicant.
  3. When moving to new UAS types it is important to note the differences between operations to avoid confusion and mistakes when preflighting the UAS.
- Skills:
  1. Applicant can inspect UAS with reference to appropriate checklist.
  2. Applicant can verify UAS is airworthy and in condition for safe flight.
  3. Applicant can give detailed and accurate crew briefing encompassing all important aspects of proposed flight.
  4. Applicant can prove all crew members are legal and safe to conduct the operation.

16.3.3 Task C. Engine Starting

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with recommended engine starting procedures.
- References:
  1. UAS Checklist
  2. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Normal engine start
  2. Safe locations for start
- Risk Management:
  1. Propeller safety at all times.
  2. Battery safety at all times.
  3. Helicopter start procedures may require a spool up time during this portion of the start control effectiveness will be reduced. Wind and control inputs should be considered to avoid risks with loss of control or dynamic roll over.
- Skills:
  1. Position UAS carefully considering structures, other UAS, wind, and safety of nearby persons and property.
  2. Proper UAS engine start procedures.

16.3.4 Task D. Engine and Controls Check

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with recommended UAS engine run up and control checks.
- References:
  1. UAS Checklist
  2. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Blade deflection
  2. Controller blade and control activation switches
  3. Run up procedures
- Risk Management:
  1. Deliberate and dedicated check effectively assessing UAS's engine performance and controls movement/throw either before or after start and this step is not overlooked or neglected which could add risk.
  2. Engine checks and control checks if done incorrectly could cause dynamic rollover.
- Skills:
  1. Complete appropriate checklist.
  2. Preform proper UAS engine run up procedures.

12.4 Takeoff and Landings

16.4.1 Task A. Normal Takeoff

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal takeoff procedures.
- References:
  1. FOM Sections: 2.5.8, 2.5.15
  2. UAS Checklist
  3. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Effects of atmospheric conditions on takeoff
  2. Appropriate power settings
  3. Appropriate UAS configuration
- Risk Management:
  1. Selection of acceptable takeoff area and risks associated with it (such as debris which could be thrown out from rotor wash).
  2. Collision hazards, to include other UAS and obstacles during takeoff phase.
  3. Distractions, loss of directional control, improper task management during critical phase of flight.
- Skills:
  1. Preform pretakeoff briefing.
  2. Ability to clear takeoff area.
  3. Apply smooth and complete takeoff power from standstill until airborne hover.
  4. Climb and maintain a initial safe flight attitude for low level hover.
  5. Complete the appropriate checklist.

16.4.2 Task B. Normal Decent and Landing

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal decent and landing procedures.
- References:
  1. FOM Sections: 2.5.4, 2.5.15
  2. UAS Checklist
  3. UAS Manufacturer Documents (if applicable)
- Knowledge:
  1. Effects of atmospheric conditions on landing.
  2. Stabilized approaches.
  3. Change in flight characteristics when entering the landing phase.
  4. Landing briefing.
- Risk Management:
  1. Selecting suitable landing area and risks associated with it.
  2. Collision hazards, to include, other UAS and obstacles.
  3. Distractions, loss of directional control, improper task management during critical phase of flight.
  4. Assessment and avoidance of dynamic rollover.
- Skills:

1. Proper landing briefing.
2. Consider wind conditions, landing surface, obstruction, and select proper runway or landing area.
3. Ensure UAS is aligned properly with the landing area.
4. Ensure landing area is clear.
5. Establish appropriate stabilized approach. Adjust pitch and collective to maintain stability.
6. Make smooth, timely, and correct control inputs during flare and touchdown.
7. Touchdown within 10 feet of a predetermined point at a speed which is safe and recommend for landing.
8. Execute a timely go around if the approach cannot be made within the tolerances specified above or for any other condition that may result in an unsafe approach or landing.

16.5 Introductory Flight Maneuvers

16.5.1 Task A. Tail Facing Collective Free Hover

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with flying a tail facing collective free hover.
- References:
  1. FOTM Training Section
- Knowledge:
  1. Control input and UAS response
  2. Orientation determination
  3. Collective free hovering technique
- Risk Management:
  1. Collision hazards, to include UAS, terrain, and obstacles. The area selected for this maneuver considers these factors.
  2. Ability to return to tail facing hover if orientation is lost.
- Skills:
  1. Clear the area.
  2. Select altitude and distance away which sufficient for orientation and optimal visibility but provides enough safety margin.
  3. Collective free technique to hold helicopter within +/-10 feet of predetermined altitude.
  4. Keep tail oriented to the pilot throughout the maneuver +/- 15 degrees.
  5. Hold stable hover to these standards for 30 seconds.

16.5.2 Task B. Orientation Based Hover: Left, Right, and Forward-Facing

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with different orientations-based hovers.
- References:
  1. FOTM Training Sections

- Knowledge:
  1. Control input and UAS response
  2. Orientation determination
  3. Collective free hovering technique
  4. Flying in region of reverse command
- Risk Management:
  1. Collision hazards, to include UAS, terrain, and obstacles.
  2. Effects of quick or incorrect reactions when UAS is in “region of reverse command”.
  3. Ability to recover and return to known tail facing hover if orientation is lost throughout maneuver.
- Skills:
  1. Clear the area.
  2. Select altitude and distance away which sufficient for orientation and optimal visibility but provides enough safety margin.
  3. Collective free technique to hold helicopter altitude +/-10 feet of predetermined altitude.
  4. Keep tail or nose oriented to requested heading throughout the maneuver +/- 15 degrees,
  5. Hold stable hover to these standards for 30 seconds.

16.5.3 Task C. Circles Around A Point

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with turns around a point.
- References:
  1. FOTM Training Sections
- Knowledge:
  1. Control input and UAS response.
  2. Flight path and ground track.
  3. Flying in the region of reverse command
- Risk Management:
  1. Collision hazards, to include UAS, terrain, and obstacles.
  2. Effects of quick or incorrect reactions when UAS is in “region of reverse command”.
- Skills:
  1. Clear the area.
  2. Select altitude sufficient for VLOS and obstacle avoidance.
  3. Complete one 360-degree orbiting turn around a ground point. The longitudinal axis of the UAS should point towards the center of the point throughout the maneuver.
  4. Constant altitude throughout the maneuver +/- 10 feet.
  5. Enter and end maneuver with hover on same heading +/- 15 degrees.

16.5.4 Task D. Horizontal Transients with Level Turns

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with horizontal transients with level turns.

- References:
  1. FOTM Training Section
- Knowledge:
  1. UAS horizontal tracking characteristics
  2. Level turning abilities of UAS
  3. Flying when changing orientation and in the region of reverse command
  4. Controls required changing from turning to flying phase
  5. Altitude loss during turns
  6. Different helicopter turning techniques
- Risk Management:
  1. Collision hazards, to include UAS, terrain, and obstacles.
  2. Effects of quick or incorrect reactions when UAS is in “region of reverse command”.
- Skills:
  1. Select altitude sufficient for VLOS and traffic and obstacle avoidance.
  2. Achieve stable forward flight at level altitude on a horizontal flight path with reference to the pilot +/- 15 degrees at a constant altitude +/-15 feet.
  3. Maintain consistent altitude when entering and exiting the turning phase from straight horizontal transient flight +/- 15 feet.
  4. Exit each turn sequence to arrive on heading that was 180 +/- 15 degrees from entry.
  5. Applicant has the ability to fly one circuit while maintaining these tolerances.

16.6 Complex Flight Maneuvers

16.6.1 Task A. Spinning Hover

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with flying a spinning hover.
- References:
  1. FOTM Training Sections
- Knowledge:
  1. Control input and UAS response
  2. Orientation determination
  3. Constantly changing control inputs in dynamic maneuvers to get stable flight effects
- Risk Management:
  1. Collision hazards, to include UAS, terrain, and obstacles. The area selected for this maneuver considers these factors.
  2. Effects of quick or incorrect reactions when UAS is in “region of reverse command”.
- Skills:
  1. Clear the area.

2. Select altitude sufficient for VLOS, mistakes, and obstacle avoidance.
3. Start maneuver with a tail facing orientation.
4. Apply constant rudder in one direction to achieve a constant rate of spin about UAS vertical axis.
5. Manipulate controls to achieve a constant hover altitude and position withing 15 feet and 20 feet respectively while rudder is constantly spinning.

16.6.2 Task A. Rapid Deceleration or Quick Stop

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with the rapid deceleration (quick stop) maneuver.
- References:
  1. FOTM Training Section
- Knowledge:
  1. Control input and UAS response
  2. Helicopter controllability during immediate stop
  3. Possible environmental factors and situations which would require a quick stop maneuver
- Risk Management:
  1. Collision hazards, to include UAS, terrain, and obstacles. The area selected for this maneuver considers these factors.
- Skills:
  1. Clear the area.
  2. Select altitude sufficient for VLOS and obstacle avoidance
  3. Establish stable horizontal track at cruise speed and heading +/- 10 degrees.
  4. Preform rapid deceleration or quick stop maneuver to abruptly decrease the forward movement of the UAS while holding altitude and heading to +/- 10 feet and +/-10 degrees.

16.7 Emergency Operations

16.7.1 Task A. Unusual attitudes and Undetermined orientation

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a UAS unusual attitudes.
- References:
  1. FOTM Training Sections
- Knowledge:
  1. VLOS rules and regulations
  2. Control inputs effect on UAS movement
  3. Autolevel and inherent stability of UAS
- Risk Management:
  1. Effects of improper and drastic control inputs in unusual attitudes.
  2. Attitude awareness at extended distances.
- Skills:

1. Ability to determine orientation and recover UAS into level flight attitude in timely manner in location well within VLOS.
2. Ability to determine orientation and recover UAS into level flight attitude in timely manner at a distance on the boundary of VLOS.

16.7.2 Task B. Low Fuel / Low Battery

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a low fuel or low battery emergency while flying the UAS.
- References:
  1. FOM Sections: 2.18, 2.19, 2.34
  2. UAS checklist
  3. FOTM Training Sections
- Knowledge:
  1. UAS battery and fuel limitations
  2. UAS response to low fuel or battery situation
  3. Possible actions to extend UAS battery life or fuel
  4. How to prepare UAS position to for possible autorotation
- Risk Management:
  1. Added risk with aggressive control inputs and flying faster in order to make emergency landing.
  2. Battery driven systems which draw substantial power and have potential to fail first.
- Skills:
  1. Determine suitable landing area.
  2. Preform actions to extend fuel or battery life.
  3. Preform emergency landing in timely manner as safe as possible.
  4. Complete emergency checklist or memory items.

16.7.3 Task C. Power Failure During Hover

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with power failure during a low altitude hover.
- References:
  1. UAS checklist
  2. FOTM Training Section
- Knowledge:
  1. Immediate action items and emergency procedures
  2. Safe landing zone
  3. Emergency memory items
  4. Immediate landing or autorotation techniques
- Risk Management:
  1. Flight at low altitude and limited landing options.
  2. Added risk with aggressive control inputs at low altitudes.
  3. Inability to have immediate recognition of failure and ability to immediately initiate safe autorotation.
- Skills:
  1. Correct immediate landing and autorotation techniques.

2. Quickly configure the UAS in accordance with manufactures recommendations for existing circumstances.
3. Establish suitable landing area considering time, altitude, wind, terrain, obstructions, and available surfaces.
4. Touchdown with minimum sideward movement and no rearward movement.
5. Apply controls to minimize vertical descent during flare.
6. Complete the appropriate emergency checklist or memory items.

16.7.4 Task C. Power Failure at Altitude

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a power failure at altitude.
- References:
  1. UAS Checklist
  2. FOTM Training Section
- Knowledge:
  1. Immediate action items and emergency procedures.
  2. Abbreviated landing briefing.
  3. Safe landing zone.
  4. Autorotation technique.
- Risk Management:
  1. Flight at low altitude and limited landing options.
  2. Added risk with aggressive control inputs.
  3. Immediate recognition of failure and ability to immediately initiate safe autorotation.
- Skills:
  1. Correct autorotation techniques.
  2. Configure the UAS in accordance with manufactures. recommendations for existing circumstances.
  3. Pick safe landing zone.
  4. Establish suitable landing area considering time, altitude, wind, terrain, obstructions, and available distance.
  5. Establishes stable decent.
  6. Touchdown with minimum sideward movement and no rearward movement.
  7. Conserve blade energy to arrest descent during flare.
  8. Complete the appropriate emergency checklist or memory items.

16.7.5 Task C. Power Failure Emergency Landing With 180 Degree Autorotation

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a power failure requiring an emergency landing and 180-degree autorotation.
- References:
  1. UAS checklist
  2. FOTM Training Sections
- Knowledge:
  1. Immediate action items and emergency procedures

2. Abbreviated landing briefing
3. Safe landing zone
4. Autorotation techniques
5. Situations which would require a 180-degree autorotation

- Risk Management:
    1. Flight at low altitude and limited landing options.
    2. Added risk with aggressive control inputs and turning effects on available lift.
    3. Immediate recognition of failure and ability to immediately initiate safe autorotation while turning to avoid obstacle.
    4. Turning lower to the ground, with no power, while in a decent.
- Skills:
    1. Correct autorotation techniques.
    2. Configure the UAS in accordance with manufactures recommendations for existing circumstances.
    3. Picks safe landing zone.
    4. Establish suitable landing area considering time, altitude, wind, terrain, obstructions, and available distance.
    5. Complete a 180 degree turn from original heading which occurred at start of maneuver +/- 20 degrees.
    6. Establishes stable decent.
    7. Touchdown with minimum sideward movement and no rearward movement.
    8. Conserve blade energy to arrest descent during flare.
    9. Complete the appropriate emergency checklist or memory items.

16.8 Shutdown and Securing UAS

16.8.1 Task A. Shutdown and Securing UAS

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a shut down and securing operations.
- References:
    1. FOM Sections: 2.9.2, 2.9.3, 2.5.14
    2. UAS Checklist
- Knowledge:
    1. UAS shutdown, securing, and postflight inspection
    2. UAS disassembly and storage procedures
    3. UAS required documentation
    4. Required logbook entries
- Risk Management:
    1. Inappropriate activities and distractions pose added risk.
    2. PIC professional and proper decision making until completion of *entire* flight.
    3. Towards end of flight it is crucial to avoid rushing and unsafe practices.
- Skills:

1. Complete appropriate checklist.
2. Shutdown and power down of all applicable components.
3. Proper disassemble and storage UAS.
4. Correct and comprehensive post flight debrief.
5. Correct and complete logbook entries.

Chapter 17. Airman Certification Standards - Airship

17.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate or rating being exercised in order to act as pilot in command (PIC). UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the aeronautical knowledge and flight proficiency standards pertaining to the certification of pilots flying airship category UAS. The certification for this chapter consists of a practical test or checkride in which the DO expects the evaluator to assess the applicant's mastery of the topic in accordance with the level of learning most appropriate for the specified task. This practical test consists of both a ground, sometimes referred to as oral, and flight portion. The ground portions main purpose is to test the applicant's mastery of topics in a discussion format while the flight portion is more tailored to applicant's flight proficiency operational considerations. The oral question may continue throughout the entire practical test.

The evaluator is required to test the applicant on all categories listed below during the oral and practical stages of the checkride being conducted for the approval of this certificate. For certification under a different difficulty level decrease the originally stated tolerance by 20% for level 2 difficulty rated UAS and 40% for level 3 difficulty rated UAS. If a new maneuver is required for certification on a higher difficulty level UAS the task title will have asterisk after the title. Two asterisks will indicate a maneuver which is required for certification on a level two difficulty rated UAS. Three asterisks will denote a maneuver which is required for certification on a level three difficulty rated UAS. If no asterisks are present the maneuver is required for the basic level one difficulty rated UAS certification as well as for the level two and three difficulty rated UAS but with reduced standards (20 or 40 percent).

17.2 Preflight Preparation

17.2.1 Task A. Pilot Qualifications

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating themselves as PIC.
- References:
    1. FOM Sections: 2.2, 2.3.1, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.9, 2.7, 2.9, 3.1.3, 3.3.3
- Knowledge:
    1. Initial PIC requirements
    2. Flight currency
    3. Privileges and limitations
    4. Medical qualifications
    5. Documents required to exercise privileges

- Risk Management:
    1. Failure to distinguish between currency and proficiency.
    2. Failure to ensure fitness for flight.
    3. Failure to Identifying hazards when piloting unfamiliar UAS or using unfamiliar display or control systems.
- Skills:
    1. When evaluator presents example, applicant can determine requirements to act as PIC under the given flight rules and situational conditions.
    2. Applicant knows and can show evaluator the required documents which need to be on and available when acting as PIC.

17.2.2 Task B. Airworthiness Requirements

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating the UAS type intended for flight.
- References:
    1. FOM Sections: 2.4.1, 2.8, 4.2.2, 4.3, 9.1, 9.2, 9.3
- Knowledge:
    1. UAS flight manual, marking, and placard requirements
    2. UAS ownership requirements
    3. Initial airworthiness
    4. Continuing airworthiness
    5. LIPO battery storage and use
    6. Aircraft discrepancies
    7. Aircraft registration
- Risk Management:
    1. Inoperative or nonairworthy equipment may be difficult to recognize and must be dealt with appropriately. This may be a new process for the applicant, so familiarity and practice are important for safety and risk mitigation.
    2. UAS abides by constantly changing FAA, COA, and FOM regulations regarding maintenance, placards, and airworthiness. Rules change over time and the applicant is familiar with where to find new rules and regulations.
- Skills:
    1. Applicant can describe the UAS airworthiness and registration information and process.
    2. In scenario given by the evaluator applicant can determine if the UAS is airworthy.
    3. Applicant can explain continuing airworthiness and its importance.
    4. Applicant understands the differences between preflight procedures on different types of UAS.

17.2.3 Task C. Weather

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating UAS weather requirements.

- References:
    1. FOM Sections: 2.6
    2. COA
    3. How To Read A MEATAR
    4. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Weather minimums
    2. Cloud clearance requirements
    3. METAR
    4. Max wind limitations on airship
- Risk management:
    1. Determining possible weather which warrants a flight cancelation.
    2. Changing weather and environment effects on safe operation.
    3. Risks with flights in adverse weather.
    4. Plan for non forecast winds or atmospheric conditions effecting airships structure and flight plan.
- Skills:
    1. Using the blanket COA weather minimums and standard cloud clearance requirements the applicant is able to determine if UAS flight is possible.
    2. Given a current METAR applicant has ability to accurately determine location, visibility, height of lowest ceiling.
    3. Using UAS flight documents determine if flight under certain weather conditions is possible and plan for any non-forecast weather and its effects on the flight (UAS components which change with changing atmosphere).

17.2.4 Task D. National Airspace System, COA, and Flight Planning

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating in the national airspace system (NAS) under the current UCB blanket COA.
- References:
    1. FOM sections: 2.4
    2. COA
    3. An Introductory Guide to Airspace and Use of a VFR Sectional Chart
- Knowledge:
    1. Types of airspace and associated requirements
    2. Chart symbology
    3. SUA
    4. TFR
    5. Airport proximity
    6. Sectional chart time reversions
- Risk management:
    1. Airspace may be new to applicant and guessing unknown airspace may lead to added risk and safety concerns.

2. Various classes of airspace have different regulations, look similar, and can be difficult to decipher which could cause confusion to a new applicant.

- Skills:
  1. Applicant can determine the airspace in a certain location from a scenario given by the evaluator.
  2. Applicant understands airspace reversions and can correctly navigate the different websites and sources to find the correct information.

17.2.5 Task E. Gas Filling, Loading, and Performance

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with the predicted outcome and performance based on UAS gas filling, loading, and environmental conditions.
- References:
  1. UAS Manufacturer Documents
- Knowledge:
  1. UAS weight limitations
  2. UAS gas limitations
  3. UAS ballonet limitations (if applicable)
  4. UAS balance limitations
  5. Envelope inflation
  6. UAS performance
  7. Possible flight characteristics outside limitations
- Risk management:
  1. Inability to understand and comply with UAS loading and weight limits.
  2. Procedures with lifting gas to avoid leaks, exposure, and contamination.
  3. Effects of incorrect filling of lifting gas on natural static buoyancy.
- Skills:
  1. Knowing the required weight limitations for the lifting gas used and have the ability and skill to enter the correct amount.
  2. Safely filling the airship and loading it with the appropriate amount of weight while considering what is needed to maintain the correct buoyancy.
  3. Demonstrate the calculations and plan for what the pilot determines to be the correct buoyancy for that days flight.

17.3 Preflight Procedures

17.3.1 Task A. NOTAM Submission

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with UAS NOTAM submission.
- References:

1. FOM Sections: 2.4.2
2. COA
3. NOTAM Submission Guide

- Knowledge:
    1. Familiarity with filing database
    2. Location format: determination, size, documentation, and verification
    3. Valid time format: length and correct time zone
- Risk Management:
    1. Unfamiliarity with location designation submission format may cause improper submission thus providing unclear or unusable information.
    2. Inability to make realistic submissions could cause confusion to other NAS users.
- Skills:
    1. Applicant can file a NOTAM which accurately covers and corresponds to the location and time of proposed flight, which is consistent with all FOM, COA, and FAA regulations.

17.3.2 Task B. Preflight Assessment

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating the UAS as airworthy before flight.
- References:
    1. FOM Sections: 2.5.14, 2.8.3, 4.2.2, 4.3
    2. UAS Checklist
    3. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Pilot self-assessment
    2. UAS specific preflight actions
        - What items must be inspected
        - The reason for checking each item
        - How to detect possible defects
    3. Checklist usage
    4. Initial crew briefing
- Risk Management
    1. Inoperative or nonairworthy equipment may be difficult to recognize and must be dealt with appropriately. This may be a new process for the applicant, so familiarity and practice are important for safety and risk mitigation.
    2. Decision making to terminate the flight early or upon receipt of unairworthy information when external pressures exist may be very difficult for a first-time applicant.
    3. When moving to new UAS types it is important to note the differences between operations to avoid confusion and mistakes when preflighting the UAS.
- Skills:

1. Applicant can inspect UAS with reference to appropriate checklist.
2. Applicant can verify UAS is airworthy and in condition for safe flight.
3. Applicant can give detailed and accurate crew briefing encompassing all important aspects of proposed flight.
4. Applicant can prove all crew members are legal and safe to conduct the operation.

17.3.3 Task C. Gas Fill, Buoyancy, and Control Check

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with recommended gas fill, buoyancy, and control check.
- References:
    1. UAS Checklist
    2. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Normal buoyancy
    2. Safe locations for buoyancy check
    3. Control surface and propulsion check
    4. Tiedown procedures
    5. Lifting gas properties
    6. Airship filling procedure
- Risk Management:
    1. Weather and wind effects on a gas filled balloon.
    2. Preplanned procedure for fly away event.
    3. Gas filling risks with leaking or measuring.
- Skills:
    1. Position UAS carefully considering structures, other UAS, wind, and safety of nearby persons and property.
    2. Calculate the correct amount of lifting gas needed for the flight.
    3. Complete the proper gas filling procedure to the recommended gas pressure within the allowable limits prescribed by the manufacture.
    4. Proper tie down or fly away prevention procedures.
    5. Complete proper UAS buoyancy and control checks.

17.4 Takeoff and Landings

17.4.1 Task A. Normal Takeoff and Climb

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal takeoff procedures.
- References:
    1. FOM Sections: 2.5.8, 2.5.15
    2. UAS Checklist
    3. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Effects of atmospheric conditions on takeoff
    2. Appropriate power settings
    3. Appropriate UAS configuration

- Risk Management:
    1. Selection of acceptable takeoff area and risks associated with it.
    2. Collision hazards, to include other UAS and obstacles during takeoff phase.
    3. Distractions, loss of directional control, improper task management during critical phase of flight.
- Skills:
    1. Ability to clear takeoff area.
    2. Position UAS determined takeoff location.
    3. Smoothly apply required takeoff power and gas vent or ballonet settings.
    4. Maintain safe climb attitude to maintain safe and adequate climb rate.
    5. Adjust as necessary to compensate for wind to ascent in predetermined path.
    6. Complete the appropriate checklist.

17.4.2 Task B. Normal Decent and Landing

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal decent and landing procedures.
- References:
    1. FOM Sections: 2.5.4, 2.5.15
    2. UAS Checklist
    3. UAS Manufacturer Documents (if applicable)
- Knowledge:
    1. Effects of atmospheric conditions on landing.
    2. Stabilized approaches.
    3. Landing briefing.
    4. Effects of varying lifting gas, weight, or ballonets if applicable for decent
- Risk Management:
    1. Selecting suitable landing area and risks associated with it.
    2. Collision hazards, to include, other UAS and obstacles.
    3. Distractions, loss of directional control, improper task management during critical phase of flight.
    4. Go around procedures if landing cannot be completed as desired and complications if gas, weight, or ballonets were used for decent.
    5. Confirming go around flight path is free of obstacles and obstructions and the airships performance is known if a go around is necessary.
- Skills:
    1. Proper landing briefing.
    2. Consider wind conditions, landing surface, obstruction, and select proper runway or landing area.
    3. Ensure UAS's projected path is aligned with the landing zone and path is free of obstructions.

4. Ensure runway or landing area is clear.
5. Establish appropriate approach, decent, and landing. Adjust controls to maintain stabilized approach.
6. Make smooth, timely, and correct control inputs during round out and touchdown to ensure a low energy landing.
7. Touch down at the suitable safe decent speed recommended by manufacture or predetermined by the pilot in a touchdown zone which is predetermined within a 20 ft radius or distance.
8. Execute a timely go around if the approach cannot be made within the tolerances specified above or for any other condition that may result in an unsafe approach or landing.

17.5 Performance and Ground Reference Maneuvers

17.5.1 Task A. Box Pattern

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with flying a box pattern.
- References:
    1. FOTM Training Sections
- Knowledge:
    1. Control input and UAS response
    2. Orientation determination
    3. Ground track producing even box like dimensions
        - Wind effect on UAS to hold location
    4. Constant altitude holding techniques
    5. Effects of wind on ground track and ground speed
    6. Knowledge of controls effecting UAS turning and yawing abilities and their effect on pitch or thrust in a turn
- Risk Management:
    1. Collision hazards, to include UAS, terrain, and obstacles. The area selected for this maneuver considers these factors.
    2. Inability to put control inputs which help compensate for climbing or descending tendencies while turning.
- Skills:
    1. Clear the area.
    2. Select altitude sufficient for VLOS and obstacle avoidance.
    3. Fly even box pattern with reference to ground track which resembles an even box pattern holding center line with drift correction to within +/- 20 feet.
    4. Using knowledge of wind determine effect of time spent on each leg.
    5. Hold altitude to within +/- 15 feet.

17.5.2 Task B. Straight Transects

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a straight transect flight.
- References:

        1. FOTM Training Section
- Knowledge:
    1. Control input and UAS response
    2. Straight ground track
        - Wind effect on UAS to hold position
    3. Control inputs effecting the region of reverse command
- Risk Management:
    1. Collision hazards, to include UAS, terrain, and obstacles.
    2. Effects of quick or incorrect reactions when UAS is in “region of reverse command”.
- Skills:
    1. Clear the area
    2. Select altitude sufficient for VLOS and obstacle avoidance
    3. Fly to predetermined point within 50 feet without reference to instruments or video downlink.
    4. Ability to complete 180 degree turn and fly UAS in opposite direction with precision to reach the start point within 50 feet.
    5. Ability to hold a flight path along the center line of the transect to withing +/-20 feet.

17.5.3 Task C. Climbing 180-degree Turn

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a climbing 180-degree turn
- References:
    1. FOTM Training Section
- Knowledge:
    1. Control input and UAS response
    2. Varying altitude and heading
        - Effect on combining controls for desired attitude changes on overall performance.
    3. Situations requiring a 180-degree climbing turn
    4. Flying in the region of reverse command with non-level flight maneuvers
- Risk Management:
    1. Collision hazards, to include UAS, terrain, and obstacles.
    2. Effects of quick or incorrect reactions when UAS is in “region of reverse command”.
- Skills:
    1. Clear the area.
    2. Select altitude sufficient for VLOS and obstacle avoidance.
    3. Complete one 180-degree climbing turn with normal configuration to obtain max altitude.
    4. Achieve an altitude change acceptable for the UAS performance available.
    5. Complete a 180 degree turn within +/-20 degrees.

17.5.5 Task E. Rapid Ascents and Descents

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated rapid ascents and descents.
- References:
  1. FOTM Training Section
- Knowledge:
  1. UAS ability to rapidly ascent or descent
  2. UAS systems which aid in ascents or descents
  3. Correct UAS procedure to achieve max ascent or descent
  4. What situations would require a rapid ascent or descent
- Risk Management:
  1. UAS risks with rapid ascent or descent resulting in structural damage.
  2. Effects of flying after emergency systems have been used or activated.
- Skills:
  1. Clear the area.
  2. Configure the UAS for normal maneuver or cruise flight as specified by manufacture or evaluator.
  3. Begin maneuver with correct procedure to quickly transition from the inflight cruise to climb or descent phase.
  4. Become stabilized in climb or descent for 5 seconds or more.
  5. Complete maneuver by transition from stabilized phase and leveling off at new altitude and hold that altitude for 5 seconds +/- 15 ft.
  6. Execute the maneuver to gain as much altitude or lose as much altitude as possible. This should be done with the technique which best meets this skill requirement. This can be done with direct ascent/descent or a combination of forward movement and ascent or descent.

17.5.6 Task E. Turns Around A Point

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with turns around a point.
- References:
  1. FOTM Training Section
- Knowledge:
  1. Control input and UAS response
  2. Constant altitude
     - Effect on pitch control or power with change yaw or turning controls
  3. Flying in the region of reverse command
- Risk Management:
  1. Collision hazards, to include UAS, terrain, and obstacles.
  2. Effects of quick reactions when UAS is in “region of reverse command”.
- Skills:

1. Clear the area.
2. Select altitude sufficient for VLOS and obstacle avoidance.
3. Select suitable ground reference area for maneuver.
4. Complete one 360-degree orbiting turn around a predetermined ground point. The lateral axis of the UAS should point towards the center of the point throughout the maneuver.
5. Radius of turn is prespecified and held to within 20 feet.

17.6 Emergency Operations

17.6.1 Task A. Loss of Orientation

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a UAS loss of orientation scenario.
- References:
    1. FOTM Training Section
- Knowledge:
    1. VLOS rules and regulations
    2. Control inputs effect on UAS movement
    3. Autolevel and inherent stability of UAS
- Risk Management:
    1. Altitude awareness at extended distances.
    2. Effects of quick reactions when UAS is in “region of reverse command”.
- Skills:
    1. Ability to determine orientation and return UAS into VLOS in timely manner.

17.6.2 Task B. Low Fuel / Low Battery

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a low fuel or low battery emergency while flying the UAS.
- References:
    1. UAS checklist
- Knowledge:
    1. UAS battery and fuel limitations
    2. UAS response to low fuel or battery situation
    3. Possible actions to extend UAS battery life or fuel.
- Risk Management:
    1. Added risk with aggressive control inputs and flying faster.
    2. Battery driven systems which draw substantial power and could fail first.
    3. Consideration to normal static starting buoyancy and ability to get UAS to descend before loss of power or after loss of power.
- Skills:
    1. Determine suitable landing area.

2. Preform vital actions to ensure quick UAS descent even if power if control power is lost.
3. Preform emergency landing.

17.6.3 Task C. Envelope Emergencies and Gas Leak

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with an envelope emergency and gas leak.
- References:
  1. UAS checklist
  2. FOTM Training Section
- Knowledge:
  1. Causes, remedies, and action items for puncture or rip in the gas envelope or ballonet
  2. Causes, remedies, and action excessive lifting gas loss
  3. Causes, remedies, and action for rain/icing on envelope
  4. Emergency valve operations
  5. Emergency air to gas operations
  6. Safe landing zone
  7. Situations that require an emergency landing
  8. Stabilized approach to include concepts of energy management
  9. Mitigation of circumstances which could lead to envelope emergencies
- Risk Management:
  1. Added risk with simulation of envelope emergency events.
  2. Added risk with aggressive control inputs, rapid descents, and emergency landings.
- Skills:
  1. When given a scenario the applicant is able to identify the problem and use the appropriate rational to troubleshoot the issue.
  2. If an emergency landing is necessary then the applicant can execute a safe emergency landing in a quick but safe amount of time.
  3. Complete the emergency checklist or memory items.

17.7 Shutdown and Securing UAS

17.7.1 Task A. Shutdown and Securing UAS

- Objective: To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with a shut down and securing operations.
- References:
  1. FOM Sections: 2.9.2, 2.9.3, 2.5.14
  2. UAS Checklist
- Knowledge:
  1. UAS shutdown, securing, and postflight inspection.
  2. UAS gas removal.

3. UAS disassembly and storage procedures.
4. UAS required documentation.
5. Required logbook entries.

- Risk Management:
  1. Inappropriate activities and distractions.
  2. PIC professional and proper decision making until completion of *entire* flight.
  3. Towards end of flight it is crucial to avoid rushing and unsafe practices.
- Skills:
  1. Complete appropriate checklist.
  2. Shutdown and power down of all applicable components.
  3. Drain all gas per the manufactures recommended procedure.
  4. Proper envelope and ballonets deflation.
  5. Proper disassembly and storage UAS and its components.
  6. Correct and complete logbook entries.

Chapter 18. Airman Certification Standards – Visual Observer (VO)

18.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate or rating being exercised in order to act as a Visual Observer (VO). UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the aeronautical knowledge and flight proficiency standards pertaining to the certification of Visual Observers.

The evaluator is required to test the applicant on all categories listed below during the oral and practical stages of the checkride being conducted for the approval of this certificate.

The initial VO certification grants permission for the applicant to act as a UCB certified VO for all UAS types during daytime VFR conditions. To act as a VO for nighttime operations, additional training is required.

18.2 Preoperative Knowledge

18.2.1 Task A. Pilot Qualifications

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating themselves as a VO.
- References:
    1. FOM Sections: 2.3.1, 2.3.4, 2.7, 3.2
- Knowledge:
    1. Initial VO Requirements.
    2. Privileges and Limitations.
    3. Medical Qualifications.
    4. Documents required to exercise privileges.
- Risk Management:
    1. Failure to distinguish between currency and proficiency with the VOs ability to remember and understand regulations and practices.
    2. Failure to ensure fitness for flight.
- Skills:
    1. When evaluator presents example, applicant can determine requirements to act as VO under the given situational conditions.
    2. Applicant can determine when VO is required, what regulations pertain to the VO, and what regulations the VO must follow.
    3. VO presents valid medical qualifications.

18.3 Visual Observer Operation

18.3.1 Task A. VO Responsibilities and Actions In UAS Flight Operations

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with operating as a VO.
- References:
  1. FOM Sections: 2.3.1, 2.3.3, 2.5.2, 2.5.11
  2. COA
- Knowledge:
  1. Preflight briefing
  2. Knowledge of VO roles
  3. Crew teamwork and predetermined necessary roles
- Risk Management:
  1. Failure to identifying hazards when acting as VO in unfamiliar mission profiles or environments.
- Skills:
  1. Applicant can determine what is considerable to be reported based on prebriefed and safety knowledge.
  2. Applicant can visually scan the surroundings for manned and UAS traffic, obstructions, and other possible elements which would interference with the safety of the flight operation.
  3. Applicant can pass a scenario-based evaluation set evaluator testing different realistic flight scenarios.
  4. VO is not unnecessarily distracting to the PIC.
  5. VO observer has enough knowledge and familiarity with phraseology and aviation vocabulary to clearly communicate and understand conversations between PIC and VO.

18.4 Post Flight

18.3.1 Task A. Post Flight Actions

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with VO post flight actions.
- References:
  1. FOM Sections: 2.9, 2.11.2
- Knowledge:
  1. Logbook requirements
  2. SARS
- Risk Management:
  1. Failure to have accountability and record VO operation and times.
  2. Failure to understand importance of role and take responsibility on providing feed back or asking questions.
- Skills:
  1. Applicant can accurately fill out VO logbook correctly and on time.

2. Applicant has knowledge of SARs report and knows basic requirements for submission.
3. Applicant understands post flight debrief procedure and has ability to state any abnormalities of safety issues with the previously flown flight.

Chapter 19. Airman Certification Standards – CFI

19.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate or rating being exercised in order to act as a UCB CFI. UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the aeronautical knowledge and flight proficiency standards pertaining to the certification of UCB CFIs.

The evaluator is required to test the applicant on all categories listed below during the ground (oral) and flight stages of the practical checkride being conducted for the approval of this certificate.

For final certificate approval the CFI applicant must be appointed by the DO, complete the UCB CFI curriculum, and past this ACS practical test.

The CFI checkride is a general certification which can be completed in any UAS category, difficulty level, or type and once accomplished applies to all other UAS categories and types. Due to this fact, the ACS listed below only has CFI specific tasks and testing requirements. For the practical test, both the ground and flight portion, the evaluator will expect and test the applicant's instructional wisdom on the UAS category task standards which are needed for the UAS initial PIC checkride for the category of UAS being used. Not all UAS category ACS task sections which pertain to the UAS initial checkride will be tested but rather only the normal tasks which are incidental to the ground and flight portion of this CFI practical test. Failure to conform to or complete the required tasks of the category UAS ACS could result in a test failure or discontinuance at the discretion of the evaluator. Although the initial PIC category ACS will be used and referenced, the majority of the practical test will have emphasis on the tasks listed in the sections below as this is what has been determined important testing areas for CFI applicants.

19.2 Preoperative Tasks

19.2.1 Task A. CFI Qualifications

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating themselves as a CFI.
- References:
    1. FOM Sections: 2.3.1, 2.7, 3.1.3 3.4
- Knowledge:
    1. Initial CFI requirements

2. Privileges and limitations
3. Recency experience
4. Documentation required to exercise privileges

- Risk Management:
  1. Failure to understand and have familiarity with pertinent regulations.
  2. Perceptional need to self-certify proficiency as an instructor on unfamiliar UAS.
- Skills:
  1. Applicant can determine what CFI privileges and limitations exist.
  2. Applicant can state what is required to act legally as a CFI.

19.2.2 Task B. CFI Fundamentals of Instructing

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with fundamentals of instructing.
- References:
  1. FOTM CFI Training Sections
- Knowledge:
  1. Required student needs which must be met before learning can occur
  2. Barriers to effective communication
  3. Different types of teaching methods
  4. Elements of instructor critics
  5. The general teaching processes
- Risk Management:
  1. Applicant cannot determine if student is correctly retaining the newly learned information and continues teaching thus creating confusion.
  2. CFI or students' emotions interfere with learning and create hazardous situations as a result of frustration in the learning process.
- Skills:
  1. Applicant can create a general teaching or lesson plan based on any CFI authorized privilege area.
  2. When given a scenario the applicant can vary a teaching approach to convey information in a different but effective way.
  3. Applicant can evaluate if student retained knowledge to determine if learning took place.

19.3 Operative Tasks

19.3.1 Task A. CFI Flight Skills

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with operating UAS to higher CFI standards.
- References:

    1. Relevant ACS Sections
    2. Relevant FOTM Training Sections
- Knowledge:
    1. Relevant ACS standards for maneuvers to be preformed
    2. Teaching knowledge on each maneuver to be performed
- Risk Management:
    1. Reference risks associated with the task section of the maneuver being flown.
- Skills:
    1. Applicant can fly ACS UAS specific category maneuvers comfortably to the required standards. Use appropriate ACS standards.

19.3.2 Task B. Flight Instruction

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with effectively teaching while flying.
- References:
    1. Relevant ACS Sections
    2. Relevant FOTM Training Sections
- Knowledge:
    1. ACS
    2. Teaching methods
- Risk Management:
    1. Multitasking while flying or the added distraction of supervising a student could create poor teaching qualities or safety hazards.
    2. CFIs new to instruction may not recognize student flying errors.
- Skills:
    1. Applicant can clearly and correctly explain each UAS maneuver while flying said maneuver (if applicable).
    2. Applicant can determine if student performance complies to standards.
    3. Applicant can provide helpful insight to improve students flight maneuvers.

Chapter 20. Airman Certification Standards – Examiner

20.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate or rating being exercised in order to act as a responsible UCB examiner authority. UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the aeronautical knowledge, risk management, and flight proficiency standards pertaining to the certification of UCB examiners.

The evaluator is required to test the applicant on all categories listed below during the ground (oral) and flight stages of the practical checkride being conducted for the approval of this certificate.

For final certificate approval the examiner must be appointed and approved by the DO, complete the UCB CFI curriculum, and past the ACS practical test.

20.2 Preoperative Tasks

20.2.1 Task A. Examiner Qualifications

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating themselves as an examiner.
- References:
    1. FOM Sections: 2.3.1, 2.7, 3.5
- Knowledge:
    1. Initial examiner requirements
    2. Privileges and limitations
    3. Recency experience
    4. Documents required to exercise privileges
- Risk management:
    1. Failure to understand and know all regulations which pertain to examiners actions, responsibilities, and privileges.
- Skills:
    1. When evaluator presents example, applicant can determine requirements to act as examiner under the given current or situational conditions.

20.2.2 Task B. Departmental Operations

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with departmental operations.
- References:
    1. FOTM Examiner Training Section
- Knowledge:
    1. UCB flight operations department certification process
    2. UCB flight operations department training process
    3. Logbook entries
    4. Checkride requirements
    5. Checkride standardization process
    6. Different training sessions
    7. Checkride scheduling
- Risk management:
    1. Inability to understand and unfamiliarity with knowledge areas has possibility to create unjust, unfair, actions which could reflect poorly on department.
- Skills:
    1. When given a scenario applicant can prove to evaluator that all knowledge areas are well known and can be applied to real world situations.

20.2.3 Task C. Evaluation Skills

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluation pertaining to evaluation skills.
- References:
    1. FOM Sections: 3.2.2, 3.3.2, 3.4.2, 3.5.2, 3.6, 3.7
    2. ACS
    3. FOTM Examiner Training Section
- Knowledge:
    1. Testing and evaluation methods
    2. Different personality and pilot types
    3. Maneuver standards
    4. Proper judging procedures and standards
- Risk management:
    1. Inability to accurately determine an applicant's attitude could lead to the certification of a unsafe and hazardous UAS pilot.
- Skills:
    1. Ability to determine an applicant's knowledge of subject through testing and questioning. When presented a scenario from the evaluator the examiner applicant must determine if the senerio student has the required knowledge which would meet or exceed the required ACS standards.
    2. Examiner applicant has ability to determine an applicant's personality though examiner expertise. The examiner must be able

to determine if an applicant possess any hazardous attitudes and or unsafe intensions.
3. Examiner applicant has ability to properly assess if flight maneuvers meet ACS standards.
4. Examiner applicant has plan and process to make clear and agreeable decisions on determining if an applicant passes a checkride.

20.3 Operative Tasks

20.3.1 Task A. Simulated or Supervised Checkride

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with conducting a complete checkride.
- References:
  1. FOTM Examiner Training Section
  2. ACS standards
- Knowledge:
  1. All elements which go into conducting a successful checkride
- Risk management:
  1. Examiner applicant has ability to professionally follow rules and regulations but also needs to be able to evaluate personality and overall decision-making skills. Examiner applicant needs to tailor the checkride based on applicants' answers and thought process. Any inability to do this or identify any applicant issues could present an issue with an unworthy certification being granted.
- Skills:
  1. Examiner applicant conducts checkride according to ACS standards with realistic form and schedule.
  2. Examiner applicant is able to identify deficient areas and target them for ensured knowledge in the area deficient or presumed to be deficient in order to get idea of applicants actual understanding.
  3. Examiner applicant is able to follow ACS guidelines but still determine if applicant meets safety and professional standards on areas not specifically tested but considered normal for typical operation.
  4. Examiner applicant is able to decisively determine if actual applicant meet ACS standards and is worthy of certification.

Note: As this certification is a test of an examiner's abilities, the examiner ACS section 20.3.1 can be complied with and completed under simulated or real-world conditions. The examiner applicant can conduct a real certification checkride with a real world applicant, under the supervision of a previously certified examiner, or complete a simulated checkride with the evaluator acting as the simulated. In the case of a real world supervised checkride evaluation, the evaluator of the examiner would be the supervisor, sign off, and have final authority of the outcome of the checkride. A plan to conduct the supervised checkride evaluation should be made between the examiner applicant and the supervisor well before the actual date of both checkrides. A plan should be put in place to discuss the logistics of the actual checkride well before the checkride date. The supervisor can and is encouraged to step in and provide suggestions throughout the checkride to the actual certification applicant to ensure all checkride certification standards are being met and provide future real world guidance to the examiner applicant. The examiner applicant must conduct the majority of the checkride and satisfactorily accomplish all the tasks listed under this examiner ACS 20.3.1 section.

20.2.3 Task B. Ground School Training

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with teaching initial PIC UAS ground school.
- References:
    1. FOTM Ground School Training Sections
    2. FOTM Examiner Training Sections
- Knowledge:
    1. Instructional knowledge of all ground school topics
- Risk management:
    1. Inability to follow the clear, concise, correct teaching format could lead to student confusion.
    2. Ground school is a students first look at the UCB flight ops department so professionalism and first impressions are important and if negative, could adversely affect the department and future student training.
- Skills:
    1. Applicant can teach a complete ground school session successfully.

This examiner *ground school training event* certification task may be completed in a simulated condition where the examiner applicant teaches a full course to the evaluator or in a real-world scenario ground school which is supervised by an already certified examiner. The applicant must use his or her training and instructional expertise in order to teach a live ground school to the evaluators, ACS, and DOs standards. As stated, this ground school will be supervised, and the certified examiner evaluator is encouraged to make additions to the ground school to better clarify or help student learning. The additions or added comments are acceptable as long as the majority of the ground school is proctored by the examiner applicant.

Chapter 21. Airman Certification Standards – Night Training

21.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate being exercised in order to act as pilot in command (PIC). UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the aeronautical knowledge and flight proficiency standards pertaining to the certification of pilots flying at night under UCB COAs. The certification for this chapter consists of a practical test, or checkride, in which the DO expects the evaluator to assess the applicant's mastery of the topic in accordance with the level of learning most appropriate for the specified task. This practical test consists of both a ground portion, sometimes referred to as oral, and flight portion. The ground portion is to test the applicant's mastery of topics in a discussion format while the flight portion is more tailored to applicant's flight proficiency operational skills. The oral question will continue throughout the entire practical test.

This is an additional night training certification which can be completed on any UAS category and once accomplished applies to all other UAS category and types. Due to this fact, the ACS listed below only has night specific tasks and testing requirements. For the practical test, both the ground and flight portion, the examiner will hold the applicant to the same UAS category task standards which were needed for the applicants initial PIC UAS checkride. Not all category ACS task sections will be tested but rather only the normal tasks which are required for this night certification practical test.

For night certification the evaluator is required to test the applicant on all tasks below regardless of the category of UAS being used. Once the night training certification practical exam has been passed the PIC has eligibility to fly any category or type UAS at night.

Applicants who wish to get certified to act as VO during night operations must receive the night ground training and receive an instructor sign off. No practical exam is required.

21.2 Preoperative Tasks

21.2.1 Task A. Pilot Qualifications

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating themselves as PIC for night operations.
- References:

1. FOM Sections: 1.2, 2.2, 2.3.1, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, 2.3.9, 2.7, 2.9, 3.1.3, 3.3.3, 3.6.1

- Knowledge:
  1. Night PIC Requirements
  2. Flight Currency
  3. Night Flight Currency
  4. Night Flight Privileges and Limitations
  5. FOM Night Definitions
  6. FOM Night practical test requirements
  7. Medical Qualifications
  8. Documents required to exercise privileges
- Risk Management:
  1. Failure to distinguish between currency and proficiency for UAS night flying.
  2. Inability to distinguish differences between operational day and operational night regulations.
- Skills:
  1. When evaluator presents example, the applicant can determine requirements to act as CFI under the given situational conditions.
  2. Applicant can determine what CFI privileges are and what limitations the CFI must abide by.

21.2.2 Task B. UAS Airworthiness Requirements

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating the UAS which is intended for the flight at night.
- References:
  1. FOM Sections: 2.4.1, 2.8, 4.2.2, 4.3, 9.1, 9.2, 9.3
  2. COA
  3. UAS Manufacture Documents (if applicable)
- Knowledge:
  1. UAS flight manual, marking, and placard requirements
  2. UAS ownership requirements
  3. Initial airworthiness
  4. Continuing airworthiness
  5. Night flight lighting requirements
  6. UAS discrepancies
  7. Aircraft registration
- Risk Management:
  1. Inoperative or nonairworthy equipment is found on preflight inspection applicant conforms with pressure and still chooses to fly.
  2. UAS lighting system is undamaged, installed correctly, and lit properly to meet the UCB and COA night flight standards.
- Skills:
  1. Applicant can describe UAS airworthiness and registration information.

2. In scenario given by the evaluator applicant can determine if the UAS is airworthy.
3. Applicant can correctly determine if installed lights meet the applicable regulation standards for legal night flight.

21.2.3 Task C. Weather

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating UAS weather requirements.
- References:
  1. FOM Sections: 2.6
  2. COA
  3. UAS Night Flying Training PP
- Knowledge:
  1. Weather minimums
  2. Cloud clearance requirements
  3. METAR
  4. UAS ability and limitations on wind and weather
  5. Night environment and effects associated with weather
- Risk Management:
  1. Unfamiliarity with weather, common weather changes, and environment when flying at night.
  2. Reduced ability to determine weather and cloud clearance requirements during nighttime flying conditions.
- Skills:
  1. Using blanket COA weather minimum and standard cloud clearance requirements the applicant can determine if UAS flight is possible.
  2. Given a current METAR applicant has ability to accurately determine location, visibility, and height of lowest ceiling.
  3. Determining possible weather which warrants a flight cancelation.
  4. Applicants ability to plan for compliance with cloud clearance and weather minimums at night.

21.2.4 Task D. Human Eye Anatomy, Illusions, and Night Deficiencies

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating human visibility and night perceptions pertaining to UAS night flying.
- References:
  1. Night Flying Training Power Point
- Knowledge:
  1. Basic human anatomy of the eye
  2. Basic night vision knowledge
  3. Night induced illusions
  4. Known night deficiencies
  5. Flight monitoring methods
- Risk Management:

        1. Inability to remember adverse effect and added complexity while operating UAS at night.
- Skills:
    1. Applicant can use night knowledge to answer scenario based UAS flight questions pertaining to obstacle avoidance, night illusions, eye anatomy, and deficiencies.
    2. Applicant can describe plan to mitigate risks of some common night disadvantages.

21.3 Flight Maneuvers

21.3.1 Task A. Box Pattern

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with flying a box pattern at night.
- References:
    1. Relevant ACS Sections
    2. FOTM Night Flight Training Section
- Knowledge:
    1. Control input and UAS response
    2. Orientation determination
    3. Lighting knowledge
    4. UAS ground track
    5. Night light placement on UAS for orientation
- Risk Management:
    1. Collision hazards, to include UAS, terrain, and obstacles. The area selected for this maneuver considers these factors.
    2. Picking suitable altitude and location to mitigate the increased risk during night flying.
- Skills:
    1. For specific performance requirements reference the ACS section for the same category of UAS to be used for the night practical exam and keep the same standards.

21.3.2 Task B. Straight Transects

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with straight transect flights at night.
- References:
    1. Relevant ACS sections
    2. FOTM Night Flight Training Section
- Knowledge:
    1. Control input and UAS response
    2. UAS flight orientation to produce straight ground track
    3. Effect of control inputs while in the region of reverse command
    4. Night light placement on UAS for orientation
- Risk Management:

1. Collision hazards, to include UAS terrain, and obstacles.
2. Effect of quick or incorrect reactions when UAS is in “region of reverse command”.
3. Ability to detect flight orientation and changes while flying at night.

- Skills:
    1. For specific performance requirements reference the ACS section for the same category of UAS to be used for the night practical exam and keep the same standards.

Chapter 22. Airman Certification Standards – On Campus Flying

22.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate being exercised in order to act as pilot in command (PIC). UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the aeronautical knowledge pertaining to on campus flying. The certification for this chapter consists of an oral knowledge test in which the DO expects the evaluator to assess the applicant's mastery of the topic in accordance with the level of learning most appropriate for the specified task. This practical test consists of only a ground, sometimes referred to as oral exam, but no flight portion is necessary. The ground portion of this test is to test the applicant's mastery of topics in a discussion format. As strictly a ground based checkride the mastery of FOM, campus procedures, and scenario-based questions will apply. Although this ACS only tests tasks pertaining to on campus flying, oral task questions from the ACS of the category of UAS intended for use on the on campus flight can be tested as well.

This additional on campus training certification will be an additional certification for the PIC applicant. Upon approval of passing this checkride the PIC will have on campus approval certification privileges for all UAS category types.

For on campus certification the evaluator is required to test the applicant on all tasks below regardless of the category of UAS being used. Once the checkride is complete with a satisfactory score the PIC has eligibility to request flight of any category UAS on campus.

22.2 On-Campus Specifications

22.2.1 Task A. Coordination and Risk Management

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with on campus flying and coordination between different relevant UCB departments.
- References:
    1. FOM Sections: 2.10
- Knowledge:
    1. Required pilot information
    2. Requests requirements
    3. Departments coordination (CUPD, CUUF, OISC, etc)
    4. Insurance requirements (if applicable)
    5. Campus procedures and operations
    6. Realistic requests

- Risk management:
    1. Failure to plan enough time for coordination between all departments.
    2. Inability to prepare and present sufficient flight plan and risk management consideration to all departments.
    3. Neglecting preplanning areas on what risks the possible flight proposes (flights over people, near buildings, more distractions, etc).
- Skills:
    1. Applicant has ability to answer scenario-based questions pertaining to what is required to fly on campus.
    2. Applicant understands who to coordinate with between different departments.
    3. Applicant can realistically manage plan and propose an on campus flight.
    4. Applicant has ability to identify UCB on campus specific risks and formulates a plan to counteract the effects.
    5. Generate a risk management plan for submission to DO scenario.
    6. Applicant can identify possible distractions for on campus flying not present in off campus flying.

22.2.2 Task B. Flight Tolerances

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with new flight tolerances pertaining to on campus flying.
- References:
    1. ACS
    2. FOTM Night Flight Training Section
- Knowledge:
    1. Surrounding environment
    2. UAS capabilities
    3. Pilot capabilities and skill
- Risk management:
    1. The effect of new environment and need for flight precision and performance.
- Skills:
    1. When presented a scenario, applicant has ability to self-certify or self-evaluate his or her skills to determine if an on-campus flight is possible.
    2. Applicant can determine the effects of flying in and around different on campus surroundings and environments.
    3. Applicant understand common flight procedures used, while on campus, to reduce risk.

Chapter 23. Airman Certification Standards – New COA

23.1 Description

The goal of the airman certification process is to ensure the applicant possesses the knowledge, risk management, and skill consistent with the privileges of the certificate being exercised in order to act as pilot in command (PIC). UCB views the ACS as a more systematic, comprehensive, and standardized approach to airman certification training and testing.

The UCB DO has published this Airman Certification Standards (ACS) chapter to communicate the standards for certification of flight under different, non blanket, COAs. The certification for this chapter consists of an ground (sometimes referred to as oral) test in which the DO expects the evaluator to assess the applicant's mastery of the topic in accordance with the level of learning most appropriate for the specified task. This practical test consists of only a ground, once again sometimes referred to as oral exam, but no flight portion. The ground portion of this test is to test the applicant's mastery of topics in a discussion format. As strictly a ground based checkride the mastery of FOM, COA specifics, and scenario-based questions will apply. Although this ACS only tests tasks pertaining to flying under a different COA, oral task questions from the ACS of the category of UAS intended for use for flight under the new COA can be tested as well.

This new COA certification will be an additional certification for the PIC applicant. Upon approval of passing this checkride the PIC will have ability and approval certification to conduct flights under that specific COA.

23.2 Preoperative Tasks

23.2.1 Task A. COA Specifics

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with the specifics of flying under this new COA.
- References:
    1. COA
    2. FOTM New COA Training Section
- Knowledge:
    1. New COA General
    2. New COA specific operations authorized
    3. New COA specific standard provisions
    4. New COA specific special provisions
    5. Blanket COA knowledge
- Risk management:
    1. Unfamiliarity with the new COA and or unfamiliarity with the primarily learned blanket COA could lead to confusion,

misinterpretation, and operative errors that cause safety or legal hazards.

- Skills:
  1. Applicant has ability to answer all questions which pertain to the specifics of the COA.
  2. Applicant has ability to answer scenario-based questions pertaining to what is required and legal to fly under the COA.

23.2.2 Task B. COA Applications

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with new COA flight applications.
- References:
  1. COA
  2. FOTM New COA Training Section
- Knowledge:
  1. Common and practical COA operations
  2. NOTAM submission guidelines
  3. Controlling agencies (if applicable)
  4. Additional authorization
  5. Airspace
  6. Additional documentation
- Risk management:
  1. Operational procedures may be difficult to understand without proper training.
  2. New COAs may or may not require different operational practices which are different from the blanket COA or completely new; this may cause confusion, safety concerns, or legal issues.
- Skills:
  1. Applicant can plan a flight under the new COA flight rules.
  2. Applicant correctly submits NOTAMs to COA and FAA standards.
  4. Under scenario based questioning applicant can answer questions pertaining to COA rules and regulations which relate to the operation.
  5. Applicant has plan and can describe ways to mitigate risk when operating under new COA.

Chapter 24. Airman Certification Standards – BFR

24.1 Descriptions

This airman certification standards section describes the typical UCB BFR subject areas. This section can be used as a general outline for UCB CFIs conducing biannual flight reviews on all UAS category and difficulty levels. A BFR consists of both a ground and flight portion. Recommended subject areas for the ground section and guidance on recommended flight maneuvers are shown below. For the purposes of this manual the general task areas are shown without completion standards – it is up to the descension of the CFI or evaluator to determine if the applicant meets the knowledge, risk management, or skill requirements of that task. All FOM BFR specific regulations must be followed through this event.

Before administering this BFR event the evaluator should have an informal discussion with the applicant on their flight experience over the past 24 calendar months. The discussion should also include any future plans pertaining to UAS use and specific areas of operation. This will allow the evaluator to better tailor the BFR to more realistic and beneficial topics which pertain to the applicants actual UAS flying.

A minimum of one hour of ground is required for completion of a BFR. This can be accomplished multiple different ways through online courses, in person examinations, or any other approved method published by the DO. Each method for conducting the ground portion of a BFR must be done with the oversight or approval from the evaluator (either the DO, UCB Examiner, or UCB CFI). A BFR ground portion must cover relevant regulations, airspace, pilot knowledge, and COA details. The specific knowledge of these requirements are, once again, left to the discretion of the evaluator.

The flight portion of the BFR must be long enough for the evaluator to determine the applicant possess the required knowledge, risk management, and skills pertaining to UCB UAS flight operations. No specific maneuvers are required but the recommended flight procedure for BFRs is referenced below. It is up to the discretion of the evaluator to determine that enough maneuvers are successfully completed to sufficiently evaluate the applicant.

The following sections titles start with “Ground Knowledge” or “Flight Operations” with relevant subject matter listed below each title. “Ground Knowledge” sections pertain more to the oral or discussion-based portion of the BFR. While “Flight Operations” section pertain more to real UAS flight operations and scenario-based judgement questions.

24.2 Ground Knowledge: Pilot

24.2.1 Task A. Recency of Experience (FOM r4 sections 2.3.6, 3.3.3)

24.2.2 Task B. PIC Responsibilities (FOM r4 section 2.2)

24.2.3 Task C. Flight Crewmember Stations (FOM r4 sections 2.3)

24.2.4 Task D. Preflight Actions (FOM r4 section 2.4, FOTM ACS Preflight Tasks)

24.2.5 Task E. Fitness for flight and Medical requirements (FOM r4 sections 2.7.1, 2.7.2, 2.7.4)

24.2.6 Task F. Careless or reckless operations (FOM r4 section 2.5.10)

24.2.7 Task G. Alcohol or Drugs (FOM r4 section 2.7.3)

24.2.8 Task H. Required documentation for COA flights (FOM r4 sections 2.9.1, UCB Current Blanket COA)

24.2.9 Task I. Pilot Personal and Master Logbooks (FOM r4 section 2.9.2, 2.9.3)

24.2.10 Task J. Specialized Training (FOM r4 section 3.6)

24.2.11 Task K. FAA Notices (FOM r4 section 2.3.8)

18.3 Ground Knowledge: UAS

24.3.1 Task A. Initial airworthiness (FOM r4 section 4.2.2)

24.3.2 Task B. Preflight checks and continuing airworthiness (FOM r4 sections 2.4.1, 4.3)

24.3.3 Task C. Maintenance records (Airworthiness Manual)

24.3.4 Task D. Night lighting requirements [If applicable] (UCB Current Blanket COA)

24.3.5 Task E. Reportable UAS specific SAR incidents and accidents (FOM r4 section 2.11 and FOM appendix)

24.3.6 Task F. FAA placard requirements (FOM r4 section 2.8.2)

24.3.7 Task G. Aircraft Ownership (FOM r4 section 2.8.1)

24.3.8 Task H. Modified and Repaired Aircraft (FOM r4 section 4.2.5)

24.4 Ground Knowledge: Environment

24.4.1 Task A. Basic VFR Weather Minimums (FOM r4 section 2.6, 2.6.1)

24.4.2 Task B. Cloud Clearance Requirements (FOM r4 section 2.6.2)

24.4.3 Task C. METARs (“How to read a METAR” supplemental document)

24.4.4 Task D. Types of Airspace (UCB Current Blanket COA, “Airspace visualization” supplemental document, “Airspace Guide” supplemental document)

24.4.5 Task E. Special Use Airspace (“Airspace Guide” supplemental guide, UCB Current Blanket COA)

24.4.6 Task F. Minimum Safe Altitudes (UCB Current Blanket COA)

24.4.7 Task G. Right of Way Rules (FOM r4 section 2.5.2)

24.4.9 Task H. Operations in the Vicinity of Military Training Routes (FOM r4 section 2.5.9)

24.5 Ground Knowledge: External Pressures and Risks

24.5.1 Task A. Working While Fatigued (FOM r4 section 2.3.7)

24.5.2 Task B. Job and Client Pressures (FOM r4 section 2.2)

24.5.3 Task C. Marginal Weather Flying (FOM r4 Current Blanket COA, FOM sections 2.11.2, 2.5.10, 2.6)

24.6 Ground Knowledge: Blanket COA

24.6.1 Task A. Airspace Requirements (UCB Current Blanket COA)

24.6.2 Task B. Altitude Restrictions (UCB Current Blanket COA)

24.6.3 Task C. Weather Limitations (UCB Current Blanket COA)

24.6.4 Task D. Speed Restrictions (UCB Current Blanket COA)

24.6.5 Task E. NOTAM Submission (UCB Current Blanket COA)

24.6.6 Task F. Airport Distance Requirements (UCB Current Blanket COA)

24.6.7 Task G. SUA and MTRs (UCB Current Blanket COA)

24.6.8 Task H. Emergency Procedure Requirements (UCB Current Blanket COA)

24.7 Flight Operations: Scenario Based Knowledge

This “Flight Operations: Scenario based knowledge” section is written to provided more specific scenario-based task sections for the evaluator and student to check off, discuss, and or be familiar with on a BFR flight. These task areas differ from the task areas stated in ground knowledge section as they are more open ended and in place to see how the applicant has developed operational considerations and skills.

24.7.1 Task A. Ground Safety

24.7.2 Task B. UAS Weight Loading Considerations

24.7.3 Task C. UAS Maneuverability and Control Input Effects

24.7.4 Task D. UAS Specific Preflight Actions and Inspections

24.7.5 Task E. Proper NOTAM Submission for Flight Area and Time

24.7.6 Task F. Complete and Proper Briefings and Flight Plan

24.7.7 Task G. Understanding of Specific Risk Associated With Flight

24.8 Flight Operations: Flight Proficiency, Maneuvers, Skills and Post BFR Debrief

This “Flight Operations: Flight Proficiency, maneuvers, and skills” section is written to provide an outline for important flight maneuvers commonly used to evaluate applicants flight proficiency and skills during testing. In general, all training maneuvers and ACS task testing maneuvers are great evaluating maneuvers which can be used on a BFR to test applicants flight proficiency and skills. As this BFR outline applies to all UAS categories, difficulty levels, and types, specific maneuvers are not listed below. The general suggestion for flight maneuvers would be ground operations, taxi (if applicable), take off, landing, emergency procedures, and flight maneuvers. Maneuvers can be the same maneuvers done for the applicants initial checkride or maneuvers which are tailored to the pilots intended or frequent flights (this provides an opportunity for evaluator suggestion or supplemental training on maneuvers which will be used in the applicants practical flight routine). Maneuver standards for published maneuvers will be found in the ACS and standards for non-published maneuvers will be at the discretion of the evaluator. Oral questioning may continue throughout the flight portion and it is encouraged for the applicant to explain maneuvers and thought process throughout the flight.

There are two outcomes of the BFR: successful signoff or addition training. If the evaluator deems the pilot acceptable a signoff will occur in which the applicant's currency is reset. If the elevator deems the UAS Pilot unprepared to exercise the privileges of a UCB UAS pilot certificate the ground and flight will be logged as training and a date for additional training or another attempt for the BFR can be scheduled.

The major goal of the BFR is to demonstrate pilot compliance to regulations, systematic approach to flight operations, and safety procedures. The BFR is also encouraged to be used as a time for the applicant to ask questions to the evaluator on confusing topics which have arose during the applicants previous 24 calendar months of practical UAS flight operations.

Appendix

A.1 Descriptions- Training Curriculum: Multirotor

Definition: The definition of a multirotor is a helicopter type UAS having more than two lift generating rotors.
Typical uses/missions: Typical uses for multirotor vary but common multirotor uses include flights involved in photography, filming, racing, data collecting, etc.
Risk associated with multirotor and missions: Multirotor relay heavily on electronics and control boards for stability. A malfunction of these control boards could be catastrophic. Multirotor have multiple engines which need to produce a predetermined required amount power in order to stabilize and control the drone. If one of these motors fails completely or partially a crash is imminent. Most drones have complex software with presets that can be hard to understand. Although it is rare, it is possible for the software to malfunction, control the UAS in undesirable ways, and take control away from the pilot. A large amount of multirotor mission involve filming and photography. Some desired photograph places are in commonly visited areas and the risk of flying over people and in congested airspace poses added risk.
Training type flying: The multirotor training that UCB provides is done in coordinates with FOTM related documents. This type of training includes the operation of a well-known and common multirotor in the industry. The training covers everything from preflight inspections, drone set up, controller settings, camera settings, takeoffs, landings, common maneuvers, emergency procedures, postflight inspections, and packing or storage. The majority of the training flights take place at model airports or designated flying areas away from additional distractions.
General characteristics: Multirotor are unique in the fact that they operate similar to a helicopter but with added inherent stability. Although some multirotor have three, six, eight, or ten motors the most common multirotor types have four motors. For this reason, in this training we will primarily refer to the "quadcopter", four motor, multirotor type UAS. This drone has four motors located on all four corners of the UAS. The motors are connected to booms which connect to the main "fuselage" of the drone. The fuselage on most quadcopter type multirotors house the electrical components, the battery, and any camera(s) or additional equipment.
Motor: Most electronic motors on quadcopter category multirotors are brushless outrunners. These motors operate on the principle of electromagnetism. You will notice that if you spin the shaft of brushless outrunner the outside of the motor spins. The outer portion of the brushless out runner is called the bell portion of the motor and it consists of a motor shell and magnets lined on the inside. The stator part of the motor is the inner part of the motor which is fix with relation to motor rotation. The stator has electromagnets which are all wired in parallel in a slightly different way, normally opposite magnets change at the same time to cause rotation of the outer portion of the motor. When power is given to the motor electricity flows through these wires, charges up the magnets, which causes rotation. Motors have naming conventions which typically include the total length and diameter along with a KV rating. There are a wide variety of

different motor ratings, sizes, and types so its important to know what type your motors are and how your motors work.

Electronics: In order to get the motors to run properly the DC battery voltage from your battery is converted and controlled though what is called an ESC (or electronic speed controller). This speed controller takes a DC input voltage and converts it to three phase alternating current which is outputted to the motors. This AC voltage is what is sent to the motor and is the main sources which causes the motors to spin. The speed controller also varies the amount of voltage and amperage output to control the power output of each motor.

Most quadcopters also have a power distribution board which takes power from the DC battery and distributes it to each motor's electronic speed controller (ESC). The power distribution bord could be part of the frame of the multirotor or could be a mounted printed circuit board.

Lastly, all multirotors have flight controllers. Flight controllers are needed to provide stability and control response. This is the brain of the multirotor and depending on the type of controller, may be programmed to include features like automatic stabilization, return to home, level hover, etc.

Battery: Most multirotors operate using LiPo batteries. Lithium polymer batteries, LiPo batteries for short, use lithium ion technology with polymer electrolytes. They are very energy dense batteries and are commonly used in devices which have weight restrictions. LiPo batteries are used commonly in UAS's but are also very common in smart phones. There is no real inherent danger with LiPos but proper storage and damage evaluation is critical for safety. Some batteries which are used to power UASs include smart technology which transmits battery data from the battery to and onboard control system which may give pass along data to the user. These batteries are more complex and must be compatible with the all communication systems.

UAS Axes: In order to better describe the drone controls, it is important to describe the different axes of a drone. There are three axes: the longitudinal axis, the lateral axis, and the vertical axis. To define these axes, lets imagine the front and back of a drone as viewed from the pilot's common flying perspective. With the multirotor laying on the ground, the axis that points from the front to the back of the drone is considered the longitudinal axis. The lateral axis runs 90 degrees to the longitudinal axis, in a plane which is level to all the motors propellers. The lateral axis can be thought of as the axis you look down when looking left and right if sitting in the multirotor. Finally, the vertical axis is the axis that points through the top and bottom of the multi rotor and can be thought of as the axis which you look through when looking directly up and down if "sitting" in the multirotor. This axis is the axis of the cross product of the lateral and longitudinal axis. The normal direction of this axis is down.

Maneuverability: Control for quadcopter type multirotors comes from varying the power of specific motors to get a desired effect. Varying all motors thrust evenly allows for the UAS to climb and descend. Varying all motors to the left or right side of the longitudinal axis creates a moment which induces roll. Varying all motors behind or in front of the lateral axis creates forward or backward pitch. Finally, yaw is controlled by keeping net thrust the same but varying the thrust of the counter rotating and non-counter rotating motors to increase the angular momentum in one direction or another.

General concept: Control of the multirotor is achieved through wireless communication and the use of a transmitter in the controller sending signals to “talk to” a receiver receiving signals on the drone.
Radio wave propagation: Signals sent from the transmitter to the receiver are electromagnetic waves which propagate through the atmosphere at roughly the speed of light. These electromagnetic waves are signals which are modulated to carry specific information which can be interpreted and use once received. When you move a control on the controller a signal is measured then modulated and sent from the transmitter to the receiver, which receives this signal, demodulates it to gather the desired sent information.
Transmitter: The transmitter is normally a built-in component in the controller. The transmitter sends desired control input data through the air via the antenna(s) mounted on the controller. It’s common for controllers to have one antenna but occasionally multiple are installed. It is important to note that antenna wave propagation comes out the side of the antenna and not through one point at the top (this is a common misconception).
Receiver: The receiver on most multirotors is built into the control board/ flight computer, but could be a completely separate piece of hardware. It works in a similar principal to the transmitter, but its goal is on receiving the information sent from the transmitter. Typically having two antennas for receiving, normally positioned at ninety degrees to each other, the data can be received in almost any orientation. Because receivers can differ is important to become familiar with the specific type of receiver on the multirotor being used for training.
On some DJI products there are actually transmitter and receivers on both the multirotor and the controller and this allows for multirotor data to be sent and displayed on the controller screen but typically a transmitter is used for UAS control and receiver is what is on the UAS and receives the desired signals inputted into the transmitter.
Multirotor controllability: This section relates similarly to the maneuverability section described above. In this section we will discuss what is done when certain controls are moved on the controller and what effect they have on the multirotor. The left stick of the controller controls throttle and yaw. When the stick is moved up or down the power on all motors speeds up or slows down. This causes the multirotor to climb and descend vertically. Moving the left stick right and left causes clockwise rotating motors to speed up and counterclockwise rotating motors to slow down. This change in angular momentum cause the multirotor to yaw left or right. Looking at the right stick. If you move the right stick up and down this controls pitch. Pushing the stick full forward causes the rear motors to spin up and raising the tail of the multirotor up and pushing the nose forward. Pulling the right stick down causes the front motors to speed up and the back motors to slow down. If held in the respective positions these actions will cause the multirotor to move forward and back. If you move the right stick right, the left motors will speed up causing a roll to the right. If you move the right stick left the right motors will speed up causing a roll to the left. If held in the respective positions these actions will cause the multirotor to move left and right. Some control boards have preprogrammed constraints to limit deflection of the multirotor and some have mixing technology which compensates for the change in lift when varying different motor speeds as the effect of some control inputs in order to hold a constant altitude.

Familiarity with your multirotor control board is key in order to successfully fly some of the required training maneuvers.
Possible RC errors: When operating wirelessly there is always a possibility for errors. Although its rare it is important to know what error possibilities exist and how to mitigate the risk. There are two main reasons for RC errors, frequency interference and antenna placement. Frequency interference could come from a lot of different sources or environmental factors like signals operating on the same frequency without preceded messages, some type of conductive shielding in the way of the signal, power losses over great distances or through different environments or weather conditions, and antenna placement could cause signals to be received out of phase or with less power than required.
Prior to arrival: A training briefing should be conducted to determine what is the main objective for the day. The student NOTAM submission should be checked for accuracy and detail before conducting the flight. It might be advantageous for the instructor to file a backup NOTAM. Before leaving for the training area in which the training flight will be conducted, confirm that all required batteries are charged and undamaged. A flight kit or UAS transportation kit should be checked for all the correct parts or components (including propellers, spare parts, buddy box cables).
Preflight preparation: The mandatory use of checklist should be one of the first lessons implemented on a training flight. This use of checklist in the preflight steps of the flight sets the mentality for the use of checklists through the rest of the flight. The checklists can be used in a call and response format or a check but verify format. The call and response technique would be reading line by line the correct call, followed by that action, and the correct response. The do and verify or check and verify method is doing all of a phases action (preflight, landing, etc) then checking your actions for completeness based on the correct checklist section. The checklist will cover the majority of the other steps discussed in the paragraph but if need the instructor should go into a more in depth explanation on certain checklist section, for example the controller boot section (keep in mind that this is most likely the students first time using a control of that type). If the controller connects to a GPS satellite review all applicable messages when the control is achieving a GPS fix. If the drone is equipped with an FPV or camera set up review all connections and applicable controller inputs. If the controller has any emergency switches review those as well and describe the scenarios in which they should be used. Finally, one final demonstration or explanation should cover the normal controls for operating that UAS.
Initial crew briefing: This briefing should follow the standard initial crew briefing with a training-oriented twist. Go over location safety hazards, a plan for any foreseeable emergencies, and describe all the flight maneuvers to be performed. Typical flight maneuvers for the initial drone training event will include those which are identical to what needs to be performed on a checkride: box pattern, straight transects, turns around a point, loss of orientation, lost link scenario, low battery emergency with emergency landing, normal landing, and normal takeoff. Describe the procedure for who will fly and when and if any instructor demonstrations will be performed.
Takeoff: Follow the checklist for a normal takeoff but explain the typical procedure in more of a discussion format to the student. For most multirotor takeoffs, the drone will be positioned in a suitable takeoff location with the motors off and the area clear. After

that the controller sequence to start the motors is initiated and the motors turn on to a low power setting. When takeoff is desired the student should slowly advance the throttle stick until the drone begins lift off. Once lift off occurs the throttle can be used to increase the rate of ascent. A stable ascent is desired for safety and control ability.
Initial flight familiarity: Once at a suitable altitude the student should play with different the controls by moving the controllers sticks around and observing the effect of the drone. Ideally varying one control to see the effect on each axis at a time is important. This initial familiarity is crucial as it is typically the first exposure a student has to hand eye coordination when flying a drone and will be the basis on what the student uses to build his or her knowledge.
Introductory flight maneuvers: For the initial flight training there are two introductory flight maneuvers which are normally taught to students. One is the box pattern and other is straight transects. The box pattern maneuver is a simple ground reference maneuver in which the pilot attempts to make an even box across the ground. Goals of this maneuver are to determine even lengths across the ground without reference to any on board camera or telemetry and based on the skill of the pilot and his/her ability to determine distance based on multirotors size and relative location. The next goal is to understand the response of the flight controls. Not over shooting corners but anticipating response of flight controls to stick movements in order to make smooth transitions at each corner. The box maneuver is completed with the drones orientation facing the same direction throughout the entirety of the maneuver. The transient flight maneuver is used to test the students ability to determine UAS distance with respect to UAS size and to demonstrate the effect of altitude loss on pitch controls (if applicable). This maneuver will start with the instructor asking the student to fly to some predetermined desired point on a straight-line path and stop whenever he or she believes to be over that point. If the drone does not have features which compensate for loss of vertical thrust with changes in pitch the drone will descend when a forward pitch control is applied, thus additional throttle is needed to maintain altitude. This maneuver is also difficult because as the drone gets farther and farther away it appears to lose altitude as well so exposure to these phenomena will be beneficial to the students understanding. This is why it is important to understand the specific tuning of the drone to determine what actions will be required to make a constant altitude straight line flight.
Complex flight maneuvers: The complex flight maneuver section is for testing the skill of the pilot when flying the drone through a ground reference maneuver which requires constant changing of control inputs to continuously change the movement of the drone when in different orientations. In the circle around a point maneuver it is important to have the “center” axis, longitudinal axis, or camera view to be fixed at one point all throughout the circle. This maneuver requires finesse and constantly changing control inputs. The goal of this maneuver is to test to smooth inputs of the pilot and show/introduce the pilot to the region of reverse command. In this region the controls are essentially reversed as the front of the drone is facing the pilot where it normally the complete opposite direction. Before starting this maneuver it may be beneficial to let the student experiment with flying the drone in a backwards orientation first.
Normal landing: A normal landing should be done in coordination with the checklist. A more in-depth teaching of the process from the instructor is desired before the student completes a normal landing for the first time. A brief overview of the importance of flying

over the landing zone at an appropriate altitude should be discussed. The major reasons are for safety and obstacle avoidance. The actual altitude should not be drastically high but high enough to avoid obstacles and low enough to reasonably predict when the drone will be right over the desired landing zone. After the area is clear a stable approach should be used all the way down to landing height. Depending on the drone type some may hover at an altitude right over the ground, landing height, until a certain control input is used to "force" the drone to land. If this is applicable to the drone used in training, that feature should be discussed.

Emergency procedures: There are three typical emergency procedures that are taught on a training event. One is a loss of orientation exercise. In this exercise the instructor will fly the drone out to the edge of VLOS and maneuver it in a way to disorient the student. When the student regains control it is up to them to determine the orientation and return the drone back to a more visible location. This should be done without the help of any onboard camera or additional sighting device. The goal in this exercise is to test the student's ability to use control inputs to coordinate the movement of the drone to what the student is seeing in order to determine its orientation. This exercise also provides a lesson on the VLOS requirements and what constitutes the max VLOS for that specific multirotor. The next emergency exercise is a lost link exercise. This is not a flight maneuver but a scenario presented in oral fashion from the flight instructor to the student. This is best done while the student is flying to simulated the stress of the actual situation and to show the student the importance of proper flight training. The lost link or fly away scenario should include a scenario in which the drone is flying in a certain direction away from the flight area. It will be up to the student to describe the course of action which he or she will take in order to prevent hazards to surroundings. The use of an emergency checklist is encouraged in the situation but the overall knowledge of the area and preflight preparation should be tested. The last emergency procedure which is done in multirotor training is the low fuel or battery exercise. In this case the instructor will tell the student to conduct and emergency landing because of low battery annunciation. The student will need to use proper judgement, checklists, and memory items to quickly but safely get the drone on the ground as quickly as possible. The goal of this exercise is to test the students ability to make sound decisions in a time of stress with the main emphasis on safety all while controlling the UAS.

After landing: The after-landing training should consist of proper checklist usage, postflight inspections, and a thorough postflight briefing. Motor shutdown should be one of the first action items after landing. Depending on the drone type the shutdown sequence can differ. It is important to explain the proper way in which the motors should be shut off. After proper motor shutdown is reviewed and completed, retrieval of the UAS should commence. It is important to make sure the student know that the propellers of the UAS should be treated with great respect until the battery is removed. While following the checklist, battery removal and multirotor disassembly should be described in detail. Although some checklists may be concise in this section, detailed explanations allow the student to make mental connections to actions which will help in future multirotor use. The post flight briefing should follow, the correct format with an example debrief or explanation of the typical debrief should be explained by the instructor to the student. A time for questions should be allowed so the student can clarify any confusing areas.

A.2 Descriptions- Training Curriculum: Fixed Wing

Definition: The definition of a fixed wing UAS is a flying machine which is capable of flight using wings that generate lift caused by the UAS's forward airspeed and the shape of the wings.

Typical uses/missions: Typical uses for fixed wing UAS vary but common fixed wing uses include flights involved in long range surveillance, air data collecting, and modeling/testing.

Risk associated with fixed wings and missions: Fixed wing UAS typically have lower risk with complete catastrophic failure when compared to multirotors or helicopters. This has a lot to do with the fact that most fixed wing UAS are built with inherent stability and have the ability to fly even after a power plant failure, some structural damage, or control surface malfunctions. Some fixed wing UAS feature redundant systems with back up controls or motors. Some fixed wing UAS have independent motor and control power incase of an engine failure. Even with a single battery powering both the engine and control surfaces in the event that the battery is drawn down substantially the motor will commonly die with enough power left to power the control surfaces. With the many new advancements of technology, electronic flight computers have been added even more fixed wing UAS to increase safety with features like autostability and programmable autopilots. With all this being said the biggest risks associated with fixed wings accidents tend to come from pilot error, mechanical issues, or loss of some type of signal. Although this category of UAS typically has inherent stability the majority of flying is done by the PIC. PICs need to know how to fly in different orientations, configurations, and environments. Because there are so many variables present and the majority of flying is PIC control it is easy for the PIC to make human errors which lead to failures. Even with the electronic stabilization software and autopilots most pilots still need to maneuver the UAS during very technical portions of the flight like takeoff and landing, this is where a lot accidents occur. Mechanical issues are less common but fixed wing aircraft have lots moving parts which undergo pretty high stresses and need to be frequently checked. Improper preflight inspections or general ware items could fail causing an accident. Lastly, fixed wing UAS rely heavily on quick signal response, and the connection between either a control signal and or video signal. Improper antenna set up or malfunctions could easily cause a catastrophic event.

Training type flying: The fixed wing training that UCB provides is done in conjunction with the above related documents. This type of training includes the operation of a typical fixed wing type UAS that is well known and common in the industry. The training covers everything from preflight inspections, typical UAS set up, controller settings, takeoffs, landings, common or complex maneuvers, emergency procedures, postflight inspections, and packing or storage. Most of the training flights take place at nearby model airports or designated flying areas away from additional distractions.

General characteristics: Fixed wing UAS operate very similar to the airplanes that fly around today. Fixed wing UAS come in a wide variety of shapes and sizes all with different advantages and disadvantages. Fixed wing UAS can be built very short coupled and run on EDF motors much like a fighter jet, or could resemble a multiengine cargo airplane much like a Hercules C-130, or a fixed wing could be a simple flying wing with either a pusher or puller motor and elevator control surfaces. For the purposes of training the fixed wing trainer used by the department is going to be a single or multigene commonly found UAS community with common and basic traits. This will provide a great foundation for the students to build their skill and learn on when they choose to fly different types.

Motor: Fixed wing UAS aircraft can have gas, nitro, electric, or no motor(s). It is common for trainer based fixed wing aircraft to have electric motors so that is what will be discussed below. Most electronic motors on fixed wing category UAS are brushless outrunners (similar to that on most multirotors so the following paragraph will be similar to the paragraph in the multirotor section). These motors operate on the principle of electromagnetism. You will notice that if you spin the shaft of brushless outrunner the outside of the motor spins. The outer portion of the brushless out runner is called the bell portion of the motor and it consists of a motor shell and magnets lined on the inside. The stator part of the motor is the inner part of the motor which is fix with relation to motor rotation. The stator has electromagnets which are all wired in parallel in a slightly different way, normally opposite magnets change at the same time to cause rotation of the outer portion of the motor. Motors have naming conventions which typically include the total length and diameter along with a KV rating. There are a wide variety of different motor ratings, sizes, and types so it's important to know how your motors work. Due to the fact that this is an outline for the initial general training event it may be adding extra confusion to talk about gas or glow engines here but that depends on the students future plans (and training can be tailored accordingly by the CFI).

Wing: The wing is one of the main components this new UAS type. A wing generates lift from both newtons laws and Bernoulli's principal. Lift varies based on atmospheric conditions, wing design, angle of attack, and much more. A in depth discussion with the CFI should take place in order to best understand these topics.

Propeller: The propeller is nothing but a vertical wing or a wing placed on a different axis. Instead of flying through the air the propeller is spun through the air in order to get a relative wind which helps create lift. Props come in many different lengths, materials, and pitch variations all of which effect the propeller performance. The differences between these and the specifics of the ones used for training should be discussed with the CFI. Motors have propellers specifications which need to be followed in order to not overstress or damage the engine.

Electronics: As previously stated most trainer fixed wing UAS are electric. They typically have DC LiPo battery to power the motor and control system. (for battery specifics see next paragraph). In order to get the motor or motors to run properly the DC battery voltage in converted and controlled though what is called an ESC (or electronic speed controller). This speed controller takes a DC input voltage and converts it to three phase alternating current which is outputted to the motor or motors. This AC voltage is what causes the motor or motors to spin. The speed controller also varies the amount of voltage output to control the power output of each motor. To connect the speed control to the battery the speed controller should be fitted with the inverse male or female connects. To connect the speed controller to the motor there are three wires which come out of the ESC and need to be connected to three wires which come out of the motor.

Control surfaces which move the aircraft through the air are actuated with servos. These servos typically get power some component of the receiver.

If the fixed wing UAS has a flight controller, this typically takes its power from the receiver which most likely takes power from the battery.

Battery: Most multirotors operate using LiPo batteries. Lithium polymer batteries, LiPo batteries for short, use lithium ion technology with polymer electrolytes. They are very energy dense batteries and are commonly used in devices which have weight restrictions. LiPo batteries are used commonly in the UAS's but are very common in smart phones. There is no real inherent danger with LiPos but proper storage and damage evaluation is critical for safety.

To combine the battery and electrics paragraphs: the battery is plugged into the ESC which is connected to the motor. The ESC has a lead which is connects to the receiver. That lead typically powers the receiver and is used as the throttle channel to control the voltage out of the ESC and into the motor based on the control input given from the controller and sent to that receiver. The receiver has many ports or channels for all the servos which get power from the battery through the receiver. Some ESCs have a BEC which changes the flow of this statement but that can be discussed with the CFI if applicable to the UAS being flown for training.

UAS Axes: In order to better describe the drone controls, it is important to describe the different axes of a fixed wing category UAS. There are three axes: the longitudinal axis, the lateral axis, and the vertical axis. To define these axes, lets imagine the front and back of a typical fixed wing airplane as viewed from the pilots perspective. With the airplane laying on the ground, the axis that points from the front to the back of the plane is considered the longitudinal axis. This axis is the axis that runs through the theoretical pilots head when looking straight forward or backward. The lateral axis runs 90 degrees to the longitudinal axis, in a plane which runs through the center of the wing. The lateral axis can be thought of as the axis the theoretical pilot look down when looking left and right. The normal direction for the lateral axis is out the right wing when viewing the aircraft from behind or in the "pilots" seat. Finally, the vertical axis is the axis that points through the top and bottom of the fixed wing UAS and can be thought of as the axis which the theoretical pilot looks through when looking up and down. This axis is the axis of the cross product of the lateral and longitudinal axis. The normal direction for the vertical axis is down when typically looking at an aircraft which is lying flat on the ground.

Maneuverability: Control for a fixed wing category UAS comes from varying different control surfaces at different locations on the airplane. To understand maneuverability, it is important to understand different elements of an airplane and the control surfaces which effect overall aircraft movement. The main part of the airplane which houses batteries, electronics, and connects all other parts of the plane together is usually called the fuselage. The wing is what runs parallel to the fuselage and what generates lift. The wing can house many different components like gear, flaps, slats, lights, and is where the ailerons are located. The ailerons are typically connected to the most rearward and furthest out portion of the wing. The empennage is the tail section of the plane. The empennage consists of the horizontal stabilizer and vertical stabilizer. The horizontal stabilizer has a movable component called the elevator and the vertical stabilizer has a movable component called the rudder. Now that all of the components have been described its time to talk about how each one effects maneuverability. When an airplane is flying wind is moving around all components. When a control surface is deflected a

surface is presented to the relative wind, this surface provides an area which the wind hits a want to force in the opposite direction.
Specifically, when the pilot wants the airplane to pitch up a command for up elevator is given. The elevator pivots up, presenting a surface into the relative wind which want to push the elevator, horizontal stabilizer, empennage, and therefore tail of the plane down. When the tail of the plane gets pushed down the nose moves up. The elevator controls pitch which is rotation about the lateral axis. Yaw is rotation about the vertical axis. When this is desired an input to the rudder is given. If the rudder is deflected left as seen from the back, the relative wind this the rudder and forces the tail right this forces the nose left. If roll is desired ailerons are deflected. Ailerons act in the same principal as the elevator and rudder but the operate simultaneously in reverse deflection. With two ailerons, one on each end of the wing, when they deflect in opposite manners, they create moments in the same direction about the longitudinal axis. This rotation about the longitudinal axis is roll.
General concept: Control of the fixed wing aircraft is achieved through wireless communication using a transmitter in the controller to “talk to” a receiver in the plane.
Radio wave propagation: Signals sent from the transmitter to the receiver are electromagnetic waves which propagate through the atmosphere at the speed of light. These electromagnetic waves are signals are modulated to carry information. When you move a control on the controller a signal is modulated and sent from the transmitter, the receiver receives this signal, demodulates it to gather the sent information and applies it to the flight computer which then sends power to the motor or power to servos which move the control surfaces.
Transmitter: The transmitter is normally a built-in component on the controller. The transmitter sends desired control input data through the air via the antenna(s) mounted on the controller. It’s common for controllers to have one antenna but occasionally multiple are installed. It is important to note that antenna wave propagation comes out the side of the antenna and not through one point at the top (this is a common misconception).
Receiver: The receiver on most fixed wing aircraft is a box type device which normally has two antennas and pin ports to plug in the throttle/battery and servo connections. It works in a similar principal to the transmitter, but its goal is on receiving the information sent from the transmitter. Because fixed wing aircraft can fly in almost any orientation having two antennas for receiving, normally positioned at ninety degrees to each other, the sent data can be received in most any orientations.
Fixed wing controllability: This section relates similarly to the maneuverability section described above. In this section we will discuss what is done when certain controls are moved on the controller and what effect they have on the airplane. The left stick of the controller controls throttles and yaw. When the stick is moved up or down the power on the motor increase and decreases respectfully. A forward force increases the speed of the motor and therefor the propeller and “pulls” the airplane though the air. Moving the left stick right and left causes the rudder to move right and left respectfully. For the reasons described above this causes the plane to yaw. Looking at the right stick; if you move the right stick up and down the elevator will move up and down thus controlling pitch. If you move the right stick right the aileron on the right side of the wing will move up and the left aileron will move down. This causes the forces to make combining

moments which roll the aircraft around the longitudinal axis. If you move the right stick to the left the right aileron will move down and the left aileron will move up.
Possible RC errors: When operating wirelessly there is always a possibility for errors. Although its rare it is important to know what error possibilities exist and how to mitigate the risk. There are two main reasons for RC errors, frequency interference and antenna placement. Frequency interference could come from a lot of different sources or environmental factors like signals operating on the same frequency without preceded messages, some type of conductive shielding in the way of the signal, power losses over great distances or through different environments or weather conditions, and antenna placement could cause signals to be received out of phase or with less power than required.
Prior to arrival: A training briefing should be conducted to determine what is the main objective for the day. The student NOTAM submission should be checked for accuracy and detail before conducting the flight. It might be advantageous for the instructor to file a backup NOTAM. Before leaving for the training area in which the training flight will be conducted, confirm that all required batteries are charged and undamaged. A flight kit or UAS transportation kit should be checked for all the correct parts or components (including propellers, spare parts, buddy box cables).
Preflight preparation: The mandatory use of checklist should be one of the first lessons implemented on a training flight. This use of checklist in the preflight step sets the mentality for the use of checklists through the rest of the flight. The checklist will cover the majority of the other steps discussed in the paragraph but if need be go into a more in depth explanation of the controller boot (keep in mind that this is most likely the students first time using a control of that type. If the controller connects to a GPS satellite review all applicable messages when the control is achieving a GPS fix. If the fixed wing aircraft is equipped with an FPV or camera set up review all connections and applicable controller inputs. If the controller has any emergency switches review those as well and describe the scenarios in which they should be used. In accordance with the checklist all control surfaces should be checked and a runup should be completed if necessary. Finally, one final demonstration or explanation should cover the normal controls for operating that UAS.
Initial crew briefing: This briefing should follow the standard initial crew briefing with an emphasis on training. Go over location safety hazards, a plan for any foreseeable emergencies, and describe all the flight maneuvers to be performed. Typical flight maneuvers for the initial fixed wing training event will include those which are identical to what needs to be performed on a checkride: box pattern, Distance flight exercise, slow flight, circle over a point, power off stalls, steep turns, various takeoff methods (if applicable), loss of orientation, lost link scenario, low battery emergency with emergency landing, engine out landings, and normal landings.
Normal training takeoff: Follow the checklist for a normal takeoff but explain the typical procedure in more of a discussion format to the student. For most fixed wing takeoffs, the airplane will be positioned in a suitable takeoff location with the motors off and the runway area clear. After that, a slow increase in throttle is applied until full power is achieved. Directional control is primarily controlled with the rudder until the aircraft is in the air. Wind corrected can be added with rudder and aileron if very strong winds are present although if winds are that strong a training flight should most likely be

rescheduled. Smooth application of elevator control is inputted when takeoff speed is reached. Once airborne elevator control should be used to hold a steady climb angle, ailerons should be used to keep the wings level, and rudder should be used to keep coordination. The first takeoff should be an instructor takeoff due to the increase risk in low level, high energy flying. Coordination should be discussed along with a brief overview of left turning tendencies. The goal for coordination should be demonstrated on initial climb out.

Initial flight familiarity: Once at a suitable altitude the student should be introduced to the controls by practicing holding straight and level flight. The importance of light control inputs should be stressed, and the main goal should just be level flight. Turns can be introduced shortly after and originally entered with only aileron and slight elevator. Familiarity with climbs and descents should follow.

Introductory flight maneuvers: For the initial flight training there are three introductory flight maneuvers which are taught to students. They are the box pattern, the distance flight exercise, and slow flight. The box pattern is a good initial flight maneuver because it introduces the students to different airplane orientations. The airplane should be slowed to a normal cruise speed and a predetermined box location should be specified. No turns should exceed 45 degrees of bank and the maneuver should be entered on a downwind leg. Smooth shallow turns with rollouts on proper headings should be demonstrated. This will help the students understand airplane control and airplane interaction with the wind. Practice with flying in the region of reverse command can be done first and the box should be made wide enough to give the student time to experiment with the orientation. The next maneuver which should be introduced is the distance flight exercise. In this exercise the student will take the airplane and fly it out to some predetermined point, then preform a 180 degree turn and come back. The emphasis for this maneuver is determining straight line ground track and learning the region of reverse command. When flying the airplane right back towards the student, who is at the controls, there tends to be a difficulty knowing how to control the plane. If something does go wrong the student’s initial action is to revert to the primary controls learned (ie the controls learned in original training with a front facing orientation). This is obviously the worst thing to do as it will normally cause the plane to continue in the wrong direction at an even faster rate. This is the purpose of teaching this maneuver. The next maneuver to do is slow flight. This maneuver will get the student oriented with the airplane at low airspeed and with additional drag. Flaps and gear should be extended, and power should be brought back until an airspeed moderately above stall. The plane should then be maneuvered though different turns to teach the student about the additional aerodynamic effects and low speed and the need for an increase in power in turns.

Complex flight maneuvers: The complex flight maneuver section includes maneuvers like circles around a point, power off stalls, and steep turn figure eights. Circles around a point are taught in order to emphasize the importance of smoothness in controls all throughout a maneuver. A circling point should be predetermined and a constant radius around that point should attempt to be achieved. Bank can vary throughout the turn as a circle ground track is desired. Wind may not be a great factor but the reaching of its effects should be included. The next complex flight maneuver is the power off stall. Slow flight should be entered first. When at a suitable altitude power should be reduced while attempting to hold altitude. The result should be a stall. Coordination should be taught I order to keep a wing from dropping. Stall recovery should be taught and emphasized strongly throughout the maneuver. Recovery will include smooth application of power, level wing attitude, and normal climb out. The discussion of typical stall scenarios can be discussed as well. Steep turn figure eights allow the student to see the performance of a plane in a highly banked turn. It will be important for the student to feel the energy of the plane in these turns to avoid an accelerated stall or loss of altitude.

Normal landing: A normal landing should be in coordination with the checklist. A more in-depth teaching of the process from the instructor is desired before the student completes a normal landing for the first time. The traffic patterned should be discussed and key point for landing which are specific to the UAS should also be briefed. Power settings for the UAS should be use and a stable approach should be conducted. It is recommended that the final leg into landing be extended for the first couple of landings in order to make sure the approach is stable. Any wind correction should be added on final and power should be reduced over the threshold of the landing area. A flare should be initiated to ensure a touchdown at the slowest possible speed. Go around procedures and instructions should be discussed and seniors which warrant a go around should be provided to the student.

Emergency procedures: There are four typical emergency procedures that are taught for fixed wing UAS training events. They include loss orientation exercise, lost link, lowe fuel or battery scenario, and engine out landings. In the loss of orientation exercise the instructor will fly the UAS out to the edge of VLOS and maneuver it in a way to disorient the student. When the student regains control, it is up to them to determine the orientation and return the drone back to a more visible location. This should be done without the help of any onboard camera or additional sighting device. The goal in this exercise is to test the student's ability to use control inputs and see the movement of the UAS to determine its orientation. This exercise also provides a lesson on the VLOS requirements and smoothness and suibtle movement of controls. When experiencing a loss of orientation, it is very important not to take drastic measures with the controls as this could lead to a catastrophic event. The next emergency exercise is a lost link exercise. This is not a flight maneuver, but a scenario presented in oral fashion from the flight instructor to the student. This is best done while the student is flying to simulate the stress of the actual situation and to show the student the importance of proper preflight preparation. The lost link or fly away scenario should include a scenario in which the UAS is flying in a certain direction away from the flight area. It will be up to the student to describe the course of action which he or she will take in order to prevent hazards to surroundings. This use of an emergency checklist can be used in the situation, but the overall knowledge of the area and preflight preparation should be tested. Another emergency procedure which is done in multirotor training is the low fuel or battery exercise. In this case the instructor will tell the student to conduct and emergency landing because of low battery. The student will need to use proper judgement and checklists to quickly but safely get the UAS on the ground as quickly as possible. The goal of this exercise is to test the student's ability to make sound decisions in a time of stress with the main emphasis on safety. When flying a fixed wing it is also important to know what systems will become compromised if battery power gets to low and in what order. Depending on the severity of the situation it might be beneficial to use a power off approach. That brings us to the last emergency procedure which is the engine out emergency landing. In this training exercise the power to the UAS will be cut and the student will need to make an on-field emergency landing. The skills required to make a power off approach should include discussions on energy and airspeed management. There should also be a discussion on the practicality of landing on the same planned runway. If altitude is to low an off-airport landing might be safer than trying to stretch the glide or maneuver to low. An off-airport landing should not be tested in a real training scenario due to unwanted damage to the training aircraft but engine out landings can be conducted if landing on the desired runway.

After landing: The after-landing training should consist of proper checklist usage, postflight inspections, and postflight briefing. Motor shutdown should be one of the first action items after landing. Depending on the airplane some taxing can be permitted and if applicable it can be conducted with the proper technique. After taxiing is completed engine shutdown can occur, which is normally nothing less than closing the throttle for electric engines or trimming out for gas/glow engines. After proper motor shutdown is reviewed and completed, retrieval of the UAS should commence. It is important to make sure the student know that the propellers of the UAS should be treated with great respect until the battery is removed. While following the checklist, battery removal and multirotor disassembly should be described in detail. Although the checklist is concise, detailed explanations allow the student to make mental connections to actions which will help in future multirotor use. The post flight briefing should follow the correct format with an example or explanation from the instructor followed by an example from the student. A time for questions should be allowed so the student can clarify any confusing areas.

A.3 Descriptions- Training Curriculum: Helicopter

Definition: A helicopter is a UAS type which has one or two rotors that are used to generate lift and propulsion to control the UAS in all axis of flight. For the purposes of a UAS OISC definition all helicopters will have variable pitch propellers on at least one rotor.
Typical uses/mission: Helicopters provide a unique advantage as they don't need any runway to take off from. Helicopters are also able to maneuver very quickly about each axis of flight. For these reasons they are typically used for filming, transporting items, crop spraying, and areal displays. The main difference between a helicopter and a multirotor would be the blades. While helicopters aren't very common in the commercial world, they still do play a very important role in some companies success.
Risks associated with missions: helicopter blades are extremely dangerous. They spin at high speeds and are much bigger than both airplane and multirotor blades. Therefor any helicopter mission conducted near people should be done with extreme caution.
Training type flying: The helicopter training that UCB provides is done in conjunction with the above related documents. This type of training includes the operation of a typical helicopter type UAS that is well known and common in the industry. The training covers everything from preflight inspections, typical UAS set up, controller settings, takeoffs, landings, common or complex maneuvers, emergency procedures, postflight inspections, and packing or storage. Most of the training flights take place at nearby model airports or designated flying areas away from additional distractions. This type flying will be done in a wide-open area away from any additional risks. Typically, flights will be conducted in a similar pattern to both multirotors and fixed wing aircraft. When training and completing maneuvers, it is important to direct the UAS's energy away from the flying pilot. For these reasons typically flying right to left and left to right is much more desired than flying forward and backward.
General characteristics: Helicopter UAS operate similar to the full scale helicopter that operate in the skies today. Helicopters UAS come in a wide variety of shapes and sizes all with different advantages and disadvantages. Helicopters can be made for heavy lifting or light for quick aerobatics, they can have two main rotos like a Chinook or one main rotor and a tail rotor like a R-44 training helicopter. For the purposes of training the helicopter trainer UAS used by the department is going to closely resemble the trainer of a full scale R-44 helicopter. The training helicopter should have a typical helicopter motor set up and doesn't have the complication of specific components used in aerobatic helicopter flying. This will provide a great foundation for the students to build their skill and learn from.
Collective stick movement: How is throttle adjusted and how is pitch of the rotor blades changed? Understand the difference between fixed rpm mode (changing blade) vs changing rpm with fixed blade. This is just what the collective controls. Typically all RC helicopters have a mix of both changing RPM and pitch angle change with stick movement. Its important to understand the throttle and pitch curves specific for your helicopter. Typically both pitch and throttle change when you move the collective stick forward and back. The rate at which these change are described in your throttle and pitch curve. Typically in normal flight mode a pitch curve will start at 0 degrees of pitch

at the lowest collective throttle setting (left stick at bottom). It will then increase to 5 degrees at the mid stick position and then 10 degrees at the high stick position. The throttle cure on the other hand starts at 0 percent throttle at the lowest stick position but increase to 70 percent at about quarter up stick movement then 80 percent at mid stick position 90 percent at ¾ stick position and 100 percent at full up stick position. Go over this curve with the instructor and understand the positives and negatives to it. If any modulation is required or desired exercise extreme caution not to over torque or overstress the motor or stall the blades with either to much pitch and not enough RPM or vice versa. It is also really important to know that small control movements are needed at all times. If immediate and drastic action is taken moving the left stick from the full forward to lower portion could cause great flying changes which require substation increases in the collective to recover. This could result in pilot induced oscillations or additional torque effects which cause the helicopter to roll in another direction without command.
Common helicopter components: This will depend on the specific set up of the helicopter but most helicopters will use a gas/nitro or electric motor to power the rotors. The motor will either be connected to a clutch or gears which is in turn connected in some way to the main rotor and tail rotor shaft. The clutch or gears can be engaged by a switch on the pilots transmitter. This is typically what will be done after the helicopter is set in a takeoff location and the pilot is ready to commence a takeoff. The controls on a helicopter consist of cyclic controls on the right stick and collective and rudder controls on the left stick. On the left stick the pilot can control the vertical assent and decent of the helicopter with the collective. When the pilot moves the collective the angle of the blades change relative to the wind, if the motor is spinning at constant RPM (which it normally does) then the blade angle change will cause a change in lift. This change in lift will cause the helicopter to ascend or descend vertically. When the left stick is moved left and right the helicopter yaws. This is accomplished though the same processes as adjusting the collective for the main blades, but it is now done for the vertical tail rotor. When the tail rotors blades are either increased or the angle is changing the tail rotor produces more or less thrust. When this happens that change in force acts at a moment through the CG and yaws the helicopter in the desired direction. The right stick controls roll and pitch. This stick changes the blade angles of the main rotor in order to create more lift on one side of the rotor as compared to the other side. When doing this, that change in force acts at a moment and causes roll or pitch. In order to achieve this, change each individual blade must move differently at different times. A mechanism called a swash plate which spins on the same shaft which spins the rotor blades is connected to servos on one end and each propeller blade on the other. The swash plate is able to move up and down as a whole but also up and down on each point which is connected to each blade (in other words it can move on each side). If the swash plate moves up and down there are linkages which also move all the blades. So if the swash plate moves up the linkages also move up and therefore move the pushrods which are connected to the blades and that increase the pitch of the blades thus increasing the angle of attack and generating more lift. If pitch or roll is desired only one side of the swash plate is moved which changes the blade angle of one blade at one point.
UAS axis: the vertical axis of a helicopter typically moves through the propeller shaft of the main rotor near the center of the helicopter. The normal direction for the vertical axis

is down (confirm?). The longitudinal axis is an axis which goes along the fuselage or typically runs in line with both the main rotor and tail rotor. This is commonly the axis which pilots think points front to back. The normal direction for this axis is right in relation to the pilot in a tail facing orientation (confirm?). The last axis is lateral axis. This axis runs through each side of the helicopter and points left and right as seen by the pilot from the back in a nose facing orientation.

Gyroscopic effects: A helicopter rotor blade is essentially one big spinning disk. Spinning disks in nature have associated phenomenon called gyroscopic effects. One of those effects is gyroscopic precession. Gyroscopic precession is a phenomenon occurring in rotating bodies in which an applied for is manifested 90 degrees later in the direction of rotation from where the force was applied.

Maneuverability: As previously discussed the swash plate controls a majority of all maneuverability in a helicopter. But in order to truly understand the specifics of what happens and gain knowledge on how to properly preflight the previous discussion on gyroscopic pression must be used. Going back to a previously stated example, if the helicopter wanted to pitch forward an upward force at the back end of the main rotor would need to be applied. This force at the back would push the tail of the helicopter up and the nose down. This force is created by moving the cyclic control to a pitch forward motion which in turn moves one side of the swash plate to increase the angle of attack (and therefor force) of a blade that is 90 degrees behind the desired force location. This is done so that gyroscopic precession is accounted for. Discuss the effects of other control inputs like roll and where the force should take place in order to achieve that outcome. Being able to have the correct knowledge of this inputs is very important because during preflight the student will be able to check the controls for the correct motion.

Differences from other UAS types: helicopters are unique because they typically use only two blades to control all aspects of maneuverability and flight. They use a wide variety of aeronautical principles in one system in order to achieve this controllability, stability, and maneuverability. Helicopters don’t have the inherent stability that an airplane or airship does nor is it as easily programmable and have autopilot stability like a multirotor but it is quite maneuverable for a pilot.

Typical helicopter flight patterns: typical flight patterns are desired to be right to left but when learning it is much easier to learn flying forward to backward. After the first initial lesions it is important to start to learn to fly right to left. The reason flying front to back is undesirable is because the energy is directed toward the PIC, VO, and any other bystander.

New flight characteristics compared to previously flown UAS: flying a helicopter is pretty unique. Familiarity with axes and control inputs of a multirotor help considerably. A helicopter tends to want to leave its last position unless properly trimmed so it will take a very active pilot to be continuously changing control inputs in order to keep level.

Additional helicopter principles: The real specifics behind why a helicopter works is because of the blades ability to produce lift. They produce lift by being moved through the air with help of the motor. Therefore lift is thought of as typically a direct function of the motor although, this is not true. In the event of an engine failure pilots can keep the energy of the blades by reducing pitch and having positive oncoming airflow. With a flat pitch there is no load on the propeller and it spins pretty freely. When the pilot is low to the ground and over a landing spot the pilot can exectute and autorotation where he/she pulls the collective up the blades AOA increase and produces a instantaneous lift for a short amount of time in which the helicopter can land. Autorotation's is where the blades are being driven by an upwards flow of air instead of engine power. Stages of an autorotation would be normal flight, initial failure, downward decent, stable decent, flair and touchdown. Level flight, entry into autorotation, decent, flare, termination

Review of concepts and any changes with new UAS category: Remote control basics are very similar to that of all other drones that have been flown. The biggest difference is understanding that the throttle and the propeller pitch are linked to one stick and are preprogrammed to very at different stick positions.

Show storage techniques: follow manufactures guidelines but its important to remove and store all LIPO batteries (also at appropriate charge). If a gas helicopter possibly drain all the fluid for storage and wipe down any exhaust remnants. The blades on a helicopter will typically fold in, they may or may not have locking pins but it is important to store the blades properly to reduce damage. Some helicopters will have removable nose cones or canopies so that can be removed, cleaned, and stored as well. When storing components its advisable to wipe down everything in order to enhance your post flight briefing and more easily detect abnormalities before next flight. Helicopters may require additional lubrication to a few of their various systems it would be important for that to be completed during this step as well.

Prior to arrival: a training briefing should be conducted to determine what is the main objective for the day. The student NOTAM submission should be checked for accuracy and detail before conducing the flight. It might be advantageous for the instructor to file a backup NOTAM 24 hours in advance just in case of improper student submission. Before leaving for the training area in which the training flight will be conducted confirm that all required batteries are charged and undamaged or all fuel is still date and in proper containers. A flight kit or UAS transportation kit should be check for all the correct parts or tools.

Preflight preparation: The mandatory use of checklist should be one of the first lessons implemented on a training flight. This use of checklist in the preflight step sets the mentality for the use of checklists through the rest of the flight. The checklist will cover the majority of the other steps discussed in the paragraph but if need be go into a more in depth explanation of the controller boot (keep in mind that this is most likely the students first time using a control of that type. If the controller connects to a GPS satellite review all applicable messages when the control is achieving a GPS fix. If the fixed wing aircraft is equipped with an FPV or camera set up review all connections and applicable controller inputs. If the controller has any emergency switches review those as well and describe the scenarios in which they should be used. In accordance with the checklist all control surfaces should be checked and a runup should be completed if necessary. Finally, one final demonstration or explanation should cover the normal controls for operating that UAS.

Initial crew briefing: This briefing should follow the standard initial crew briefing with a training twist. Go over location safety hazards, a plan for any foreseeable emergencies, and describe all the flight maneuvers to be performed. Typical flight maneuvers for the initial UAS training event will include those which are identical to what needs to be performed on a checkride: insert all ACS required maneuvers here

Engine start: Most UAS helicopter engines have an engine that runs separately from the rotors. Most engines will run at a start speed and a operation speed based on preset switches on the transmitter. Review engine start procedure. The engine is connected to the blades via a clutch. The clutch will spin a shaft which directly drives the tail and main rotor. A normal start procedure can very drastically and could depend on if the helicopter is electric or gas/nitro. Use required or appropriate training manuals from the manufacturer. Typically for gas/nitro you have a well calibrated carburetor, clutch, and motor system that will start with the help of a electrically spun shaft connection which will spin the engine and ignite with the help of a glow plug igniter. A gas/nitro engine should have a transmitter with an idle up and flight switch to allow for engine start. Once the engine has started and the glow plug igniter is removed the glow plugs themselves will keep the engine self-sustain. Electric systems have similar features but don't require the components needed for an external start. As these systems very significantly, once again please consult the manufacturers documents.
Takeoff: A typical takeoff will consist of the helicopter being in a correct position for takeoff, having the correct control inputs selected on the controller, and applying the correct take off power and controls. When everything is set up correctly and initial power is added on the collective the helicopter will start getting light on its skids, this is called "floating". After enough power is added the helicopter will become airborne. The student should then adjust the collective (left stick) to set a power in which the helicopter hovers at constant altitude. Due to the nature of the helicopter constant movement with the cyclic stick (right stick) will be needed to maintain control about pitch and roll axis while the collective is in a stationary position.
Initial flight familiarity: Before takeoff, much like the preflight actions, the student can move the controls and see what effects it will have on the helicopter. By doing this the student can get familiar to the actions which will occur as a result of their control inputs.
Introductory flight maneuvers: The first hover a student will typically learn is a collective free hover. This is a hover in which the collective is set to one setting and not touched again. Directional movement and stability is accomplished through the cyclic controlling pitch and roll. During the initial collective free hover the tail will face the pilot and the pilot will control the helicopter with reference to the nose. Helicopter pilots call this "flying the nose" where if an input of yaw to the left would result in the nose of the helicopter turning to the left. If a cyclic pitch up occurred the nose of the helicopter would rise. It is possible to "fly the tail" but this is not commonly done during training and for normal maneuvers.
Helicopters will have certain transmitter controls depending on the make and model. Some helicopters will have throttle and collective pitch increase begin at the bottom of the left stick control column and increase until max power is achieved at the top. Other helicopters will have minimum throttle collective pitch start at the midpoint of the sticks throw position and increase in positive pitch as the stick is moved up and negative pitch as the stick is moved down. It is important to know how this stock works and the effects it will have on the helicopters flight. Before the fist collective free hover it is important to understand why this is the first maneuver most pilots start with. Collective free hovering, or hovering without the collective stick, allows the student to isolate thoughts to one stick. In order to remain in a collective free hover one must only make slight changes in the cyclic stick. In order to successfully collective free hover only small cyclic inputs are

required because any great changes in the cyclic controls will cause substantial loss of lift or increase in drag and require a collective input. For example, if a great aileron input was put into the cyclic the helicopter would roll about the longitudinal axis and lose a great deal of the vertical lift generated from the blades, as a result the more pitch or throttle would be needed to counter act the loss of lift.

Complex flight maneuvers: The complex flight maneuver consist of a pure wetting hover and a rapid deceleration maneuver. In a spinning hover the pilot will place the helicopter into a constant yaw rotation with application of moderate left or right movement of the left stick. While the tail of the helicopter begins to move around it will be up to the pilot to use his knowledge of hovering in different orientations to keep the helicopter level and relatively stationary. This maneuver will show true mastery of hovering in all axis and orientations. The purpose of the rapid deceleration maneuver is to rapidly stop forward airspeed and bring the helicopter into a hover. This could be needed in an emergency situation to land after takeoff or avoid something in the air.

Landing: a normal landing will commence from about at 1-2ft hover and end with the skids firmly planted on the surface. A normal landing will start with a stable hover into the wind which will be brought down to about 1-2 feet. Once the low hover is establish the collective can be reduced to establish a slow rate of sink (a small amount of right rudder might be needed to maintain heading). Once the skids hit the surface neutralize all movement and continue to smoothly and slowly lower the collective. The collective should be moved to the full down position slowly but quickly enough to avoid movement on the skids. Add more here about cross wind landings…

Emergency procedures: the emergency procedures section is for familiarity with a loss of engine power or a tail rotor failure. These issues can be dealt with by what is called an autorotation. If the motor quits the clutch will disengage the spinning blades from the motor. This will cause the blades to spin freely and it is up to the pilot to conserve the blades energy until they are needed again. So immediately after an engine failure the blades are brought to a low pitch high speed condition. When a flare is needed they will be brought into a high pitch lower speed condition. This high pitch will help generate lift but it needs to be timed correctly so the increase in lift arrests the decent very close to the ground. This will allow the helicopter to land safely. If the pitch is increased to early the blades will run out of energy with no way of regenerating it and the helicopter will most likely crash. A 180 degree autorotation will be used if the helicopter has sufficient altitude and is on a down wind leg. Because landing with a tailwind is difficult it is important to try to land into the wind if possible. A 180 degree autorotation could also be used if desired landing zones are located behind the flight path. For a 180 degree autorotation, once again the collective will be reduced, a glide will be established, and turn towards the landing zone will be commenced. Avoid excessively steep turns and use the proper bank angle to avoid excessive energy loss. If a tail rotor fails the pilot will have a issue with controlling yaw, power should be reduced and an autorotation will be necessary (confirm this is correct and find proper examples.

After landing: The after-landing training should consist of proper checklist usage, postflight inspections, and postflight briefing. Motor shutdown should be one of the first action items after landing. Depending on the helicopter type the shutdown sequence can differ. It is important to explain the proper way in which the motor should be shut off. After proper motor shutdown is reviewed and completed, retrieval of the UAS should commence. It is important to make sure the student know that the propellers of the UAS should be treated with great respect until the battery or fuel is removed. While following the checklist, battery removal or fuel draining, and helicopter disassembly should be described in detail. Although the checklist is concise, detailed explanations allow the student to make mental connections to actions which will help in future helicopter use. The post flight briefing should follow the correct format with an example or explanation from the instructor followed by an example from the student. A time for questions should be allowed so the student can clarify any confusing areas.

A.4 Descriptions- Training Curriculum: Airship

<u>Definition</u>: a power-driven aircraft that is kept buoyant by a body of gas (usually helium, formerly hydrogen) which is lighter than air.
<u>Typical uses/mission</u>: Airships are typically used for long duration flights due to their advantage of being airborne without expending excessive energy. Airships typically only use a lifting gas to stay aloft and only using energy for propulsion or control surfaces. These long flight times could be beneficial for surveying, videography/photos, advertisement, or entertainment.
<u>Risks associated with missions</u>: Airships main advantage could also be considered a disadvantage. The lifting gas keeps the airship aloft but must be managed properly for buoyancy and accounted for in emergency situations.
<u>Training type flying</u>: The airship training that UCB provides is done in conjunction with the above related documents. This type of training includes the operation of a typical airship type UAS that is well known and common in the industry. The training covers everything from preflight inspections, typical UAS set up, controller settings, takeoffs, landings, common maneuvers, emergency procedures, postflight inspections, and packing or storage. Most of the training flights take place at nearby model airports or designated flying areas away from additional distractions. This type flying will be done in a wide-open area away from any additional risks. Airship maneuvers are typically low energy, which means the ships mass, velocity, and height are typically pretty low compared to other category types maneuvers of flying. For these reasons it is less of an issue to maneuver the airship away from the flight line when practicing maneuvers but it is good to still be aware of environmental surroundings.
<u>General characteristics</u>: Airship UAS operate remarkably similar to the full scale airships that fly in the skies today. Airship UAS come in a wide variety of shapes and sizes all with different advantages and disadvantages. Airships can be small units made for light payloads with long flight times requiring minimal power or large contraptions made for lifting more weight. A middle ground airship UAS will be used for basic training in order to understand and practice the fundamentals before moving on to bigger more complex airships.
<u>Common airship components:</u> This will depend on the specific set up of the airship but most all airships will have a lifting gas, a way to hold the lifting gas, some type of propulsion, and control surfaces. The lifting gas is a gas which is lighter than air and can be safely stored and used throughout different altitudes and temperatures. The most common types of lifting gasses are helium and hydrogen. Each gas has their advantages but the safest option and most common option for airship UAS is helium. While not the strongest lifting gas helium can provide about one gram of lifting force for every liter of gas stored. The device which holds all the lifting gas is called an envelope. The envelope can be made out of many different types of material but common material for UAS airships are gas tight, tear strength, UV resistant materials like mylar, nylon, or specialty cotton. The envelope material chose will really be based on the structure of the airship. Airships can be ridged or non-ridged; meaning there can be an internal structure or a no internal structure. Bigger airships are typically rigid airships with some type of wood, carbon fiber, metal, or composite construction holding the outside walls of the envelope up. Small airships feature non-rigid envelope construction much like a

typical party balloon in a different shape. Another common feature on most airships is the implementation and us of ballonets. Ballonets are essentially air bags inside the envelope of the airship. These ballonets can be inflated or deflated (typically with air). When a ballonet is inflated with air the ballonet expands, because this "mini balloon" is expanding in the envelope which contains the lifting gas the lifting gas is forced to condense or become less dense. When the lifting gas becomes less dense, compared to air, so does its lifting force. The ballonets operate in this way to decrease or increase the lift of the airship. Airships need some type of propulsion system to move through the air. The propulsion system in an airship is actually a control system. The propulsion system typically controls forward and rearward movement but could also control pitch and yaw depending on the propulsion set up. For most UAS flying the propulsion system is typically electric. Gas or glow engines are to heavy and complex for this operation. Electric engines don't need the cooling gas engines do, they can be turned on and off, and can be run on small batteries if weight is an issue. Most airships have gondolas to house different types of components (receiver, battery, wiring) and or the payload. Gondolas can be positioned all over the airship and can be attached multiple different ways. The most common way for a gondola to be attached is being somehow fixed to the envelope although some gondolas feature hanging designs connect to the airship via wire cables or strings.

UAS axis: the vertical axis of a airship typically moves through the base of the gondola and through the top of the envelope along its center point. The normal direction for the vertical axis is down. The longitudinal axis is an axis which goes along the envelope from front to back and is centered through the middle of the envelope. In a semi rigid airships this is typically where the bracing structure is laid though. On airships with oval type envelops the longitudinal direction runs from long direction of the envelope when looking from a side view. The lateral axis is the axis formed by the cross product of both the longitudinal and vertical axes. This is commonly the axis which pilots think points out the side of the airship.

Maneuverability: As previously discussed the airship controls its vertical ascents and descents by use of its lifting gas and ballonet system. The trust from the motors move the airship forward and backward. The control surfaces on the back of the airship will commonly control pitch and yaw. Some motors will be able to tilt and change their line of thrust. In this case some motors can control pitch, yaw, and vertical ascent or descent.

New flight characteristics compared to previously flown UAS: The main difference between airships and other UAS categories is the need for the pilot to learn and anticipate flight movement. Much like steering a boat, an airship drifts through the air and control inputs do not produce instantaneous results. The airship may develop momentum in unwanted directions which can be difficult to correct. For these reasons its important to anticipate the airships new direction and to always plan an escape route.

Review of concepts and any changes with new UAS category: Depending on the type of airship being flown and the amount of channels on the transmitter some controls may vary. On common airships a control for roll is typically not included. This means most airships can be controlled using three channels: one for thrust, one for pitch, and one for yaw. Airships with ballonets will have switches and controls for releasing or gaining air. Most of the rudders on airships use control surface and the relative airflow to create the forces necessary to move the airship, although some will have motors that crease thrust in the lateral direction causing rotation around the vertical axis (unlike a rudder no airflow is needed and yawing action can be applied anytime).

Introduce the airship used for training: ……

Show storage techniques: This process will mostly depend on the rigidity of the airship. Most non rigid airships will fold nicely into a storage bag while rigid airships will not. Typically, there is a deflation procedure involving one or a couple valves to release any of the lifting gas or ballonet air. Review these valves for the specific type of UAS to be flown and get familiar with the procedure. Airships can be stored in a number of ways from bags, boxes, to hangers and will likely depend on the manufacturers recommendations. Store the UAS to the manufacturers recommendations and be familiar with putting the airhip into and out of storage.

Demonstrate assembly: Assembly will depend on the rigidity of the airship. Most non rigid airships will need to be unfolded from a storage bag while rigid airships will not. It is important to unfold the airship neatly and carefully to avoid any unnecessary stresses causing rips or tares. If a rigid airship, make sure all connections and coverings are secure. While unfolding or assembling make sure the gondola is attached correctly as well, this is important as most of the very important flight critical devices are stored in that compartment. Assemble the motors and props if needed and complete any other steps necessary before connecting and powering on the battery. With the battery on test the airships control surface movement and motor run function (this is just a precautionary power up check before filling). Once all of that is complete it is typically time to inflate the airship. Most airships have gas filling ports somewhere around the envelope. Once accessed the airship can be filled. It's important to monitor the amount of lifting gas being added, preflight prep should be used to know the amount needed for the day. Safe practice when filling includes safety glasses, secure connections, tiedowns, ventilation, and accurate gauges.

Describe and show unique UAS airship specific systems:

Review checklist: Review the procedure for any checklist usage any anticipated flow checks that will need to be required or completed throughout the flight.

Prior to arrival: a training briefing should be conducted to determine what is the main objective for the day. The student NOTAM submission should be checked for accuracy and detail before conducing the flight. It might be advantageous for the instructor to file a backup NOTAM 24 hours in advance just in case of improper student submission. Before leaving for the training area in which the training flight will be conducted confirm that all required batteries are charged and undamaged or all lifting gas is pressurized, in date, and ready for use. A flight kit or UAS transportation kit should be check for all the correct parts or tools.

Preflight preparation: The mandatory use of checklist should be one of the first lessons implemented on a training flight. This use of checklist in the preflight step sets the mentality for the use of checklists through the rest of the flight. The checklist will cover the majority of the other steps discussed in the paragraph but if need be go into a more in depth explanation of the controller boot (keep in mind that this is most likely the students first time using a control of that type). If the controller connects to a GPS satellite review all applicable messages when the control is achieving a GPS fix. If the airship is equipped with an FPV or camera set up review all connections and applicable controller inputs. If the controller has any emergency switches review those as well and describe the scenarios in which they should be used. In accordance with the checklist set up the envelope, ballonets, and valves for inflation. If stated in the checklist tie down or secure the airship or envelope before inflation. Using the lifting gas, fill the envelope to the proper pressure or size. Then fill the ballonets. When the airship is considered full of its required gases do a stability check. Now is a typical time to power on the airship and transmitter in order to check control surfaces and other systems. If applicable, check the vents and any filling fans. Make sure the gondola is secure and any suspension wires or cables are checked.

Initial crew briefing: This briefing should follow the standard initial crew briefing with a training emphasis segment. Go over location safety hazards, a plan for any foreseeable emergencies, and describe all the flight maneuvers to be performed. Special care should be taken to have knowledge on the airships natural static buoyancy to know what would happen in a lost comms failure. Typical flight maneuvers for the initial UAS training event will include those which are identical to what needs to be performed on a checkride: insert all ACS required maneuvers here

Takeoff: A typical airship takeoff will consist of releasing the airship from its tied downs or restraints and powering the motors and control surfaces to safely get the airship from the ground to a flight attitude. A system should be put in place for the airship operator and visual observer to disconnect the airship after filling. The disconnection should be done in an open area and control checks should be done before complete release. Follow the correct checklist procedures but after release power up the motors and begin to climb to a suitable altitude in the preplanned direction.

Initial flight familiarity: Before takeoff, much like the preflight actions, the student can move the controls and see what effects it will have on the airship. By doing this the student can get familiar to the actions which will occur as a result of their control inputs. While “floating” at a safe altitude right after takeoff have the student move the flight controls around to see the different effects on the airships movement. Initially input controls to change pitch, yaw, and thrust. Different switches and controls can be manipulated as well in order to see their effects.

Introductory flight maneuvers: Initial ascents will be done primarily with power and pitch control. For an initial ascent apply forward propulsion power and up elevator. This will cause the nose of the airship to rise and the airship to climb. The basic desent should be similar; apply forward power but this time use down elevator. The controls in the rear of the airship typically need airflow to operate. A vertical ascent and descent can be done with variation of the lifting gas. Most commonly this is done with gas valves or ballonets. If the ballonets are inflated the gas in the envelope becomes more dense and the buoyancy force will decrease, thus the airship descends. If the ballonets are deflated there is more room for the lifting gas in the envelope so the density decrease and the buoyancy force increases and the airship increases. Depending on the airship design and desired phase of flight some descents can be done with gas release valves which release the lifting gas into the atmosphere causing a descent. Stationary altitude control can be set with either trim and power or lifting gas pressure and density. A desired altitude can be held with the airships lifting gas being equally buoyant to that of the forces from the atmosphere (this can be done again with ballonets or release valves). Constant forward movement and elevator trim is another technique for holding altitude. The last introductory maneuver is the box patten. The goal of the maneuver is to make a even box pattern in the sky not necessarily across the ground. The maneuver can be started in any direction along any side of the box pattern. The longitudinal axis of the airship should be aligned with the pattern of the box throughout the maneuver (thus turns are required at each point). The UAS should be set and trimmed for a predetermined altitude and all turns should be done with the rudder control. Rudder turns should be used at each point and the effect on any pitch changes or control changes should be noted and compensated for. When flying the airship towards the pilot know the region of reverse command and make small attitude correction changes in order to dampen any mistakes.

Complex flight maneuvers: The climbing 180 degree turn maneuver is a high performance maneuver in which the UAS turns 180 degree and gains the most altitude possible. This is a good maneuver used to change directions and gain more altitude and can be used in a wide variety of situations. To complete the maneuver, start in cruise flight in a predetermined direction, then simultaneously add full power, pitch up stick pressure, and left or right yaw input. Pitch and power should be set to slightly nose high and full and non changing after stabilized throughout the maneuver. Continuously change directions with the rudder until a 180-degree turn is completed. Upon completion of the turn reduce power and pitch to maintain level flight. The circle pattern is a good maneuver for surveying, advertising, or filming. The circle pattern requires a constantly changing heading and constant altitude. During this maneuver a predetermined point should be selected and a constant radius should be maintained around that point for 360 degrees. The lateral axis of the airship should point towards the center point for the duration of the maneuver. The maneuver can be entered at any point and the rate of turn should be relatively constant in a no wind situation. Rapid ascents and descents can be done in similar ways to the normal climbs and descents but with more aggressive control inputs and can be simulated in scenarios to avoid other UAS traffic or objects.

Normal Landing: Give a general landing briefing on the plan of action for landing with an emphasis on the training being done in this landing maneuver. Return to an area near the landing site at a high enough altitude to avoid traffic and other obstacles. Start a gradual decent with power and elevator while slowly beginning to set up a release valve or ballonet for level flight at the landing zone height. At roughly five feet arrest and stop the airships forward movement and start a stable vertical descent. As the airship descends know that the only real possible movement is forward, and airflow reliant control surfaces will mostly likely be completely ineffective. Plan the approach accordingly and be sure the UAS forward facing direction is oriented in a safe direction for a rejected landing go around situation. As the airship descends face the nose into the wind for drift control and begin releasing gas or adjusting the ballonets for vertical descent. Touch down on the base of the gondola or landing gear and continue to control the UAS until the VO or spotter secures the airship. Once the airship is secure the shut down or securing checklist can be started.

Emergency procedures: There are four main emergency procedures that will be covered in this paragraph. The first emergency procedure is the loss of orientation exercise. For this maneuver the instructor will take the airship to the edge of VLOS and maneuver it in a way that it is difficult for the student to know the orientation. The student will then get the controller back from the instructor and by using different control input try to determine the orientation and return the airship to the practice area. This will test the students knowledge on how different control inputs effect the airships movement. The lost link or fly away scenario is very important in airship flying as the airship can stay airborne for much longer durations than any other category of UAS discussed. It is important to attempt to set the lifting gas pressure or density to a setting which would cause a decent if a lost link is expected. Proper preflight planning is more important as the lost link travel distance could be very great. Know all emergency switches and have emergency gas dump valves set up on separate transmitter and receivers if possible. If a low battery scenario is encountered land as soon as possible. Configure the airship to start an immediate decent if the power is lost. Execute an emergency landing. Lastly, if a gas leak is encountered maneuver the airship to an suitable landing area and adjust the ballonet or valve system to arrest the decent as much as possible close to the ground. Try to minimize the time in the air and therefor the amount of gas lost.

After landing: After the airship is secured begin the powering down and gas removal process by reference to the checklist. Typically the gas vents can be open and the lifting gas can be released or recaptured. The ballonets can be vented and emptied. The controller will then typically be powered down and the airships battery unplugged. The complete deflation on disassembly process should be done in similar reverse order to the assembly process. Its important to follow the checklist and manufactures recommendations all the way through. The students logbook can be filled out and a time for debrief and questions can be scheduled or commenced.