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.x 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

<u>4.6.x Taxi</u>

- 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

<u>4.6.4 Takeoff</u>

- 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

<u>4.6.5 Initial flight familiarity</u>

- 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)

<u>4.6.6 Introductory flight maneuvers</u>

- 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

4.6.7 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

4.6.8 Autopilot operations (if appliable)

4.6.9 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

4.6.10 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

4.6.11 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 11. Airman Certification Standards – Fixed Wing

11.1 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 foundation of transition to a more systematic approach to mitigate risks associated with 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).

11.2 Preflight Preparation

11.2.1 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: 3.15, 2.25, 2.19, 2.19.1, 2.12, 2.22, 2.4, 2.41, 2.42, 2.43, 2.43.1, 2.45, 3.202, 3.21
- 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.

11.2.2 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: 2.44, 2.47, 4.14, 4.13, 5.1, 2.37, 7.5
- 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.

11.2.3 Task C. Weather

- Objective: To determine that the applicant possesses adequate knowledge, risk management, and skills associated with evaluating UAS weather requirements.
- References:
  1. COA
  2. FOM sections: 2.8, 2.81
  3. Night Flying Training PP
- 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. Determining possible weather which warrants a flight cancelation.
  2. Changing weather and environment effects on safe operation.
  3. Risks with flights in adverse weather.
- 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.

11.2.4 Task D. National Airspace System

- 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: 1.3
  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.

11.2.5 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
- 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.

11.3 Preflight Procedures

11.3.1 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: 2.22, 2.22.1 → Update with updated FOM
    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.

11.3.2 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: 2.22 → update with updated FOM
    2. UAS manufacture documents
    3. UAS Checklist
- 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.

11.3.3 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)
- 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.

11.3.4 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. Propeller direction and securing mechanism
- 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.

11.4 Takeoff and Landings

11.4.1 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. UAS Checklist
    2. 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 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.

11.4.2 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. UAS Checklist
    2. FOM sections: 2.26
    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. Energy management concerning float or sink in relation to desired touch down 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 and 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.

11.5 Performance and Ground Reference Maneuvers

11.5.1 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 45 degrees at steepest point.

11.5.2 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 50ft 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.

11.5.3 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. 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.
    4. Radius of turn is prespecified and held within 15 feet.

11.5.4 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
- Risk Management:
    1. Inadvertent slow flight leading to stall.
    2. Failure to maintain coordinated flight.
    3. Effects of environmental elements on aircraft performance.
    4. Range and limitations on stall warning indicators.
- 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 +/-20 feet.

11.5.5 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 stay coordinated.
3. Secondary stalls, accelerated stalls, and cross controlled stalls.
4. Effect of environmental elements on aircraft performance.
5. Improper stall recovery procedure.

- Skills:
  1. Clear the area.
  2. Select safe altitude no lower than 50ft.
  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. Execute a stall recovery in accordance with procedures set forth by manufacturer or what is determined acceptable by training curriculum or evaluator.
  7. Retract the flaps and gear to the recommended settings (if applicable) and commence a climb out at safe altitude and airspeed.

11.5.6 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 stay 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.
  7. Increased risk with stalling at increased power setting.
- Skills:
  1. Clear the area.
  2. Select safe altitude no lower than 50ft.
  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. 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.

11.6 Emergency Operations

11.6.1 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. FOM Sections: 2.18, 2.19, 2.34
    2. FOTM Training Sections
- Knowledge:
    1. VLOS rules and regulations
    2. Control inputs effect on UAS movement
    3. Auto level 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 on the boundary of VLOS.

11.6.2 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. 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
- 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.

11.6.3 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 Sections: 2.18, 2.19, 2.34
    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 the landing as specified by the evaluator.
    5. Execute an emergency landing in the safest way possible given the situation.
    6. Complete the appropriate checklist.

11.7 Shutdown and Securing UAS

11.7.1 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: 2.46,2.46.1
    2. UAS Checklist
    3. FOTM Training Section

- 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.
    2. PIC professional and proper decision making until completion of *entire* flight.
- Skills:
    1. Complete appropriate checklist.
    2. Shutdown and power down of all applicable components.
    3. Proper disassembly and storage UAS and its components.
    4. Correct and complete logbook entries.

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.