CIVIL AIR PATROL

U.S. Air Force Auxiliary

Mission sUAS Task Guide

Small Unmanned Aerial System (sUAS)

Mission Pilot and Technician

July 2019

Contents

O-0204

Locate a Point on a Map Using Latitude and Longitude

CONDITIONS

Given an aeronautical sectional chart, locate your position (latitude and longitude) on the chart in order to report your location to mission base, an aircraft or a ground element. Or, you are coordinating with another search element who has reported their location using latitude and longitude and you want to plot this point on your chart.

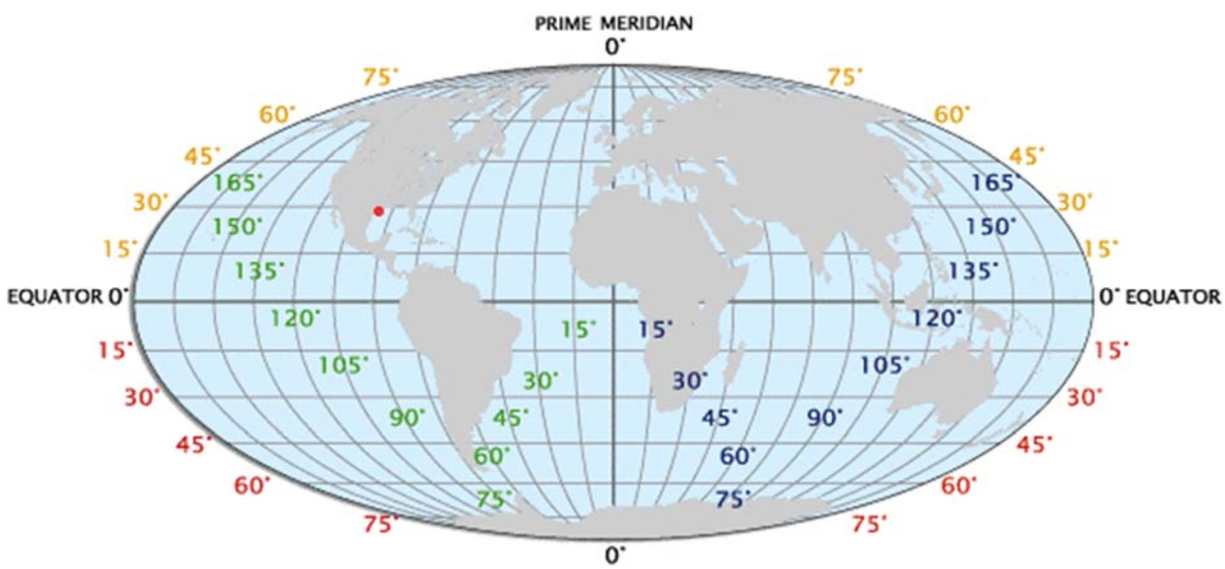
OBJECTIVES

Identify a point on a sectional chart, given its longitude and latitude. Report your position (latitude and longitude), given a point on a sectional chart.

TRAINING AND EVALUATION

Training Outline

1. As Latitude and longitude are the objective position measurements used on aeronautical charts. Many road maps and topographical maps also are gridded using this system.



   a. Lines of longitude run north-south on the map. Lines of latitude run east-west.

   b. Both latitude and longitude are measured in degrees, minutes and seconds. One minute is 1/60th of a degree, and one second is 1/60th of a minute. In the continental US, latitude numbers are read from south to north (bottom to top), and longitude numbers are read from east to west (right to left)

   c. In North America each line of latitude is labeled as North and each line of longitude is labeled as West. [Note: On geocoded map viewers, latitude is expressed as a positive number (e.g., 39.04) and longitude is expressed as a negative number (e.g., -95.37), instead of using N and W.]

   d. To read coordinates the symbol (°) means degrees, an apostrophe (') means minutes, and a double apostrophe (“) means seconds. Always read the latitude before the longitude.

e. For example, the coordinates N 39° 04.1', W 95° 37.3' are read as "north thirty-nine degrees, four point one minutes latitude, west ninety-five degrees, thirty-seven point three minutes longitude."

2. To find the lat/long designation of a known point on the chart:

   a. Find the latitude by drawing a line from the point to the nearest readable latitude line and note the degrees and minutes.

   b. Find the longitude by drawing a line from the point to the nearest readable longitude line and note the degrees and minutes.

   NOTE: If the lines fall between two "minute" marks you may estimate in "seconds" or insert a decimal such as ".5". So, if the point is halfway between two "minutes", it is at the 30 "second" or ".5" point (e.g., N 35° 10.5', W 101° 49.5').

   c. Always report latitude and longitude in the following format:

      1) Latitude as: North degrees, minutes, seconds or decimal

      2) Longitude as: West degrees, minutes, seconds or decimal

3. To plot a point given the lat/long coordinate:

   a. Find the correct latitude line and mark the sectional at the correct number of minutes (or between minutes).

   b. Find the correct longitude line and mark the sectional at the correct number of minutes (or between minutes).

   c. Draw intersecting lines from the latitude and longitude marks and mark the point of intersection.

Additional Information

Some more information on this topic is available in Chapter 8 of the MART Vol. I, Mission Scanner Reference Text and in the Ground Team Member and Leader Reference Text.

Evaluation Preparation

Setup: Mark a point on a sectional chart and give the chart to the trainee. Also, pick a different point on the sectional and note its latitude and longitude. Have a plotter available.

Brief Student: First, give the trainee the sectional with the point marked for identification. After the trainee determines the point's coordinates, orally give the trainee the latitude and longitude of the other point you noted and ask the trainee to plot this point is on the sectional.

Evaluation

Performance Measures: Results

The trainee determines the location of a known point:

Performance Measure	Results	
1. Determines the correct latitude (degrees and minutes) within tolerance. *	P	F
2. Determines the correct longitude (degrees and minutes) within tolerance. *	P	F

The trainee plots a point:

Performance Measure	Results	
3. Plots the point on the chart within tolerance. *	P	F

* The minimum accuracy for this task is to be within two minutes (longitude and latitude) of the correct answer.

Trainee must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-0205

Locate a Point on a Map Using the CAP Grid System

CONDITIONS

You are a Mission sUAS Pilot or Technician trainee and must locate a point on a gridded sectional chart.

OBJECTIVES

Demonstrate how to locate a point on a sectional chart using the CAP Grid System.

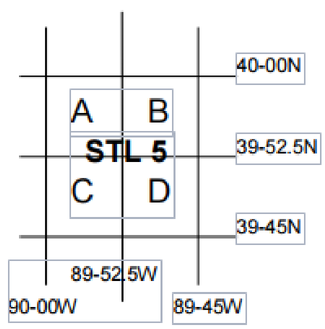
TRAINING AND EVALUATION

Training Outline

As a Mission sUAS Pilot or Technician trainee, knowledge of the CAP Grid System is essential.

This system uses a special grid system built upon the matrix of parallels of latitude and meridians of longitude and the sectional aeronautical chart. Information pertaining to this grid system can be found in Attachment E of the U.S. National SAR Supplement to the International Aeronautical and Maritime SAR Manual. This table shows the latitude and longitude boundaries of each sectional chart.

If necessary, each a 15-minute grid can be divided into four quadrants using 7 1/2 degree increments of latitude and longitude, creating four equal-size grids that are approximately 7 1/2 miles square. The quadrants are then identified alphabetically - A through D - starting with the northwest quadrant as A, northeast as B, southwest as C and southeast as D. A search area assignment (St. Louis Sectional chart) in the southeast quadrant may be given as "Search STL 5D."



Additional Information

Some more information on this topic is available in Chapter 8 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Setup: Provide the student with a gridded sectional chart and plotter.

Brief Trainee: You are a sUAS Pilot or Technician trainee asked to locate a point referenced to the CAP Grid System.

Evaluation

Performance Measures:	Results	
1. Describe the CAP grid system on a Sectional Chart.	P	F
1. Given coordinates, or an airport name, determine the CAP quarter-grid.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5001

<u>Demonstrate Aircraft & Ground Team Coordination</u>

CONDITIONS

You are a Mission sUAS Pilot or Technician trainee and must demonstrate how to coordinate with ground teams.

OBJECTIVES

Demonstrate and discuss air and ground team coordination plans and techniques.

TRAINING AND EVALUATION

Training Outline

1. As a Mission sUAS Pilot or Technician trainee, the ability to coordinate with ground teams is essential.

2. Naturally, the best means of working with a ground team is to use the radio. The UAS Tech (observer) should continuously have their eyes on the aircraft. When possible a second UAS Tech or you should use the video feed to visually monitor the ground team. The UAS Tech will work the radio to execute the coordination.

   a. It is important to understand that you have the advantage of perspective; the long-range visibility that is inherent to flying is absent from the ground. You can see over the hills, trees, and other obstacles that are blocking the ground team member's sight, so you may have to explain the situation to the ground pounder in painstaking detail.

   b. Another perspective problem is time: time seems to pass very slowly while waiting for a ground team, and it is easy to get impatient and leave station prematurely.

   c. Sometimes the ground team member may not understand radio jargon, so use plain English. For example, if you wanted a ground team to take a left at the next intersection, what would you say? How about **"Ground Team 1, Cicada Unmanned 31R41, turn left at the next intersection, over."**

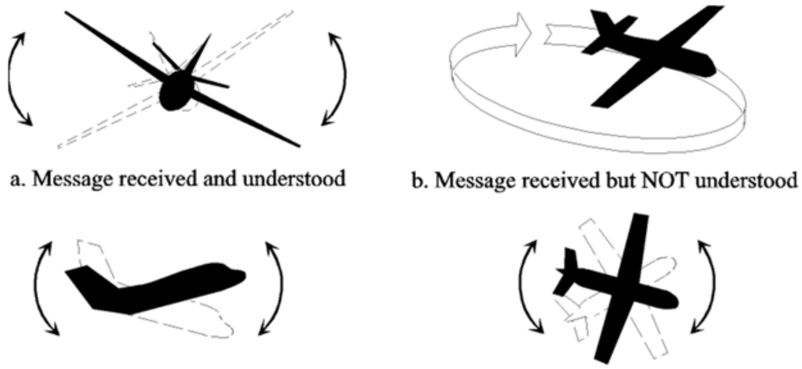
3. It is important to brief the mission with the ground team, if possible, and at least agree on communications frequencies and lost-com procedures, maps/charts to be used by both teams, determine what vehicle the ground team is driving (e.g., type, color, and any markings), determine what the ground team members are wearing (highly visible vests are preferred), and a rendezvous point and time window for rendezvous (+/- 15 minutes). One tried-and-true method is to rendezvous at a landmark that both the aircrew and the ground team can easily identify. A common rendezvous point is an intersection of prominent roads; these are easily identifiable by both the aircrew and ground team. The rendezvous location should be set up before you leave.

4. Also, ground teams that have a hand-held GPS can radio their latitude and longitude coordinates to you and say, "Come and get me!" If you are unable to loiter over the target and bring the ground team to it, you can simply radio the coordinates to the ground team and let them navigate to it on their own. This is not nearly as efficient, however, as when you lead them to it. Note that two pieces of technology have to be working properly to make this work: 1) both air and ground operators need to be proficient with their GPS units and 2) two-way radio communication must be established and maintained.

5. It is important to plan for a loss of communications during the briefing. The teams should agree on pre-arranged signals such as: stopping the vehicle means lost com; blinking headlights indicate the message has

been received; and operating the flashers means the message hasn't been received.

If communications are lost, you have a limited number of signals that can be given using the aircraft itself, as illustrated below. These signals serve as a standard means to acknowledge receiving and understanding signals



a. Message received and understood

b. Message received but NOT understood

c. Yes or affirmative

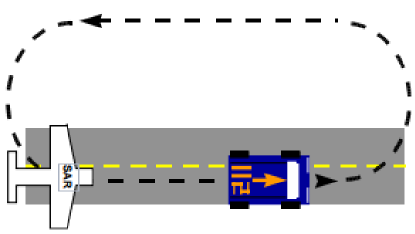
d. No or negative

from the ground. An "affirmative, I understand" response to a survivor’s signal can often be a morale booster and renew hope for imminent rescue.

Similar signals can be sent with Multirotor UAS. Descend to 100’ AGL to send these signals. In addition to the four signals shown above, there are two more that you can use to communicate with ground rescue teams. First, if you believe a ground team should investigate an area, you may fly over the team, “race” the engine or engines, and then fly in the direction the team should go. Repeat this maneuver until the ground team responds or until another means of communication is established. You may also be able to use a speaker on the UAS to communicate with the ground.

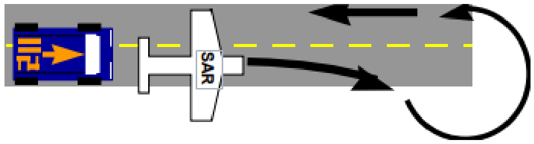
Second, you may pinpoint an area for investigation by circling above the area, continuing to do so until the ground team reaches the area and begins the search. The better the communication from ground-to-air and air-to-ground, the more coordinated the search will be and the greater the chances for success. Below are some patterns you may use to guide a ground team:

<u>Keeping contact with the ground team</u>.



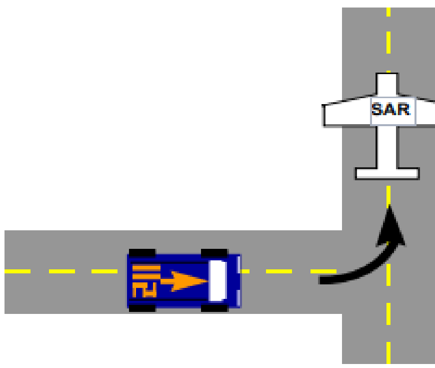
- **Aircraft action:** UAV approaches the vehicle from the rear and turns in a normal manner right (or left) to re-approach the vehicle from the rear. Circle back as necessary using oval patterns and flying over the team from behind, indicating that they should continue. This process may be referred to as a “Daisy Chain.” Daisy Chain over the ground team as long as necessary.
- **Desired team action:** Continue driving in indicated direction along this road.

Turning the ground team around.



- **UAV action:** Aircraft approaches the vehicle from the rear and then turns sharply right (or left) in front of the vehicle while in motion. Circle back as necessary, flying against the team's direction of travel, and then take up the 'keeping up' procedure outlined above.
- **Desired team action:** Turn vehicle around.

Turn.



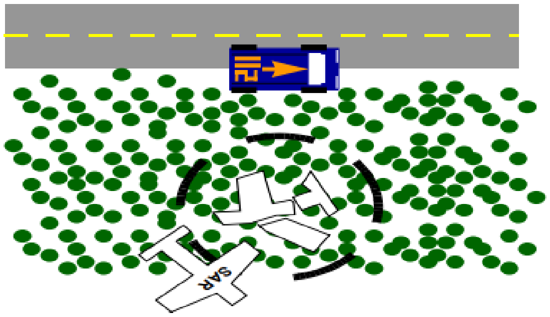
- **UAV action:** Aircraft approaches the vehicle from the rear and then turns sharply right (or left) in front of the vehicle while in motion. Circle back as necessary using oval patterns and flying over the team from behind, indicating that they should continue.
- **Desired team action:** Turn vehicle to right (or left) at the same spot the aircraft did and then continue in that direction until further signals are received.

Stop or Dismount.

- **UAV action:** Aircraft approaches the vehicle low and head-on while the vehicle is moving.
- **Desired team action:** Stop the vehicle and await further instructions.

- **UAV action:** Aircraft makes two (or more) passes in same direction over a stopped ground team.
- **Desired team action:** Get out of the vehicle, then follow the aircraft and obey further signals (proceed on foot).

Objective is here.



- **Aircraft action:** Aircraft circles one geographic place.
- **Desired team action:** Proceed to the location where the low wing of the aircraft is pointing; that is the location of the target.

Additional Information

More detailed information on this topic is available in Chapter 2 of the MART Vol. II, Mission Observer/SAR- DR Mission Pilot Reference Text.

Evaluation Preparation

Setup: The trainee needs an aircrew and a ground crew or can describe a coordination scenario.

Brief Student: You are a Mission Pilot trainee asked to guide ground units with and without communications.

Evaluation

Performance measures:	Results	
1. Discuss crew responsibilities during a combined air/ground team mission.	P	F
2. Discuss factors to consider before you or the ground team leaves mission base.	P	F
3. Demonstrate basic ground team coordination, with and without communication.	P	F

Trainee must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5002

Describe How ELT's Are Detected

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must describe how ELTs are detected and a search is launched.

OBJECTIVES

Describe how ELTs are detected and a search is launched.

TRAINING AND EVALUATION

Training Outline

1. As a UAS Mission Pilot or UAS Technician trainee, knowing the types of Emergency Locator Transmitters (ELTs), how they can be detected, and how a search is launched is essential. While the UAS Technician's scanner role seems to be concentrated in visual searches, her contributions in electronic searches are no less important. The UAS Technician's understanding of electronic search techniques, and her ability to assist the pilot, can substantially increase both search effectiveness and the timeliness of recovering accident victims.

2. ELTs. The Federal Aviation Administration (FAA) requires most U.S.-registered aircraft to have operable ELTs installed, which activate automatically when sensing acceleration forces during an accident. An active ELT transmits a continuous radio signal on a specific frequency until it’s either deactivated or its battery discharges: most transmit on 121.5 MHz at 60-100 milliwatts (less power than a small flashlight). **Space-based monitoring of 121.5 MHz ELTs ceased on 01 Feb 2009.**

   Advanced ELTs that transmit on 406.025 MHz at 5 watts are specifically designed to operate with the SARSAT/COSPAS satellite system. They also produce standard sweep tones on 121.5, 243.0 and 406 MHz, and may transmit GPS coordinates. The registered transmitter sends a coded signal that can be used to obtain the owner's name, address and type of aircraft, so AFRCC can call the number to see if the aircraft is really missing (~ 70% of the false alerts will be resolved by this call). Since geostationary satellites process the signal it will be heard more quickly and allow a much faster response (~ 6 hours saved). If the unit has a GPS receiver, it can transmit lat/long coordinates to further speed the search. The signal can also penetrate dense cover (e.g., trees). [Adoption of these ELTs will be slow by general aviation as they presently cost about three times as much as a 121.5 MHz ELT.]

   Military Beacons (e.g., URT-33/C) operate on 253 MHz. Personnel ejecting/parachuting from a military aircraft have this beacon; some pilots may be able to communicate via two-way radio on 243 MHz using a PRC-90 or later military survival radio (this radio also has a beacon mode).

   Marine Emergency Position Indicating Radio Beacons (EPIRBs) are primarily found on boats and ships. Similar to 406 or 121.5 MHz ELTs, some are automatically activated while others can only be activated manually.

   Personal Locator Beacons (PLBs) and *Personal Emergency Transmitters* (PETs) use a 406 MHz transmitter and a 121.5 MHz homing signal (at only 25 mW). Many are also equipped with a built-in GPS receiver that provides lat/long coordinates (typically to within 98 feet). Each PLB must be registered.

Test stations or practice beacons like those used by CAP transmit on 121.775 MHz. Some organizations still operate practice beacons on 121.6 MHz, but all CAP practice beacons should be converted by now. [NOTE: Avoid calling the practice beacon an "ELT" while communicating on the radio; this can cause confusion. The term "practice beacon" is very clear to all concerned and should be used on all drills and exercises.]

3. Approximately 97% of all received ELT signals turn out to be false alarms. For 121.5 MHz ELTs only 1 in 1000 signals is an actual emergency! False alarms cause problems because SARSAT can only monitor 10 ELT signals at a time and because they block the emergency frequencies (thus blocking a real emergency signal). However, you must always treat an ELT signal as an emergency because you can't know whether the signal is real or false.

4. In a cooperative effort among several nations, search and rescue-dedicated satellites (SARSAT and COSPAS) orbit the earth and alert to 406 MHz ELT transmissions. In the event the ELT is activated (such as during a crash) it transmits the standard swept tone on 121.5 and 243.0 MHz at 100 milli-watts. Additionally, every 50 seconds for 520 milliseconds the 406.025 MHz 5-watt transmitter turns on; during that time an encoded digital message is sent to the NOAA-SARSAT satellite (part of the COSPAS- SARSAT satellite system). After activation the 406.025 MHz transmitter will operate for 24 hours and then shuts down automatically; the 121.5/243.0 MHz transmitter will continue to operate until the unit has exhausted the battery power (at least 72 hours).

   The information contained in the ELT message is:
   - Serial Number of the Transmitter or Aircraft ID
   - Country Code
   - I.D. Code
   - Position Coordinates (Lat/Long), if coupled to the aircraft's GPS unit

5. 406 MHz ELTs must be registered with the United States the National Oceanic and Atmospheric Administration (NOAA). This identification code helps the Air Force Rescue Coordination Center (AFRCC) determine whether an emergency actually has occurred. The code permits accessing a registration database that contains the:
   - Owner's Name
   - Owner's Address
   - Owner's Telephone Number
   - Aircraft Type
   - Aircraft Registration Number
   - Alternate Contact

6. For 406 MHz ELTs without GPS position data it is necessary for the polar orbiting satellites to pass overhead, using Doppler Shift technology to determine approximate position; this results in position accuracy of 1-3 nm. If the ELT is coupled to the aircraft's GPS unit, the position data is also transmitted, and position accuracy improves to within 100 yards. [Note: in a worst-case scenario, there could be a 3-4 hour wait for a polar orbiting satellite to pass overhead.]

7. AFRCC uses the registration data to inquire about the whereabouts of the aircraft (e.g., contacts know the owner if flying or the FAA has a Flight Plan on file). If AFRCC determines the aircraft is really missing, they will immediately launch a search.

8. Upon receiving SARSAT coordinates and registration details, the CAP Alert Officer will notify an Incident Commander to launch a search. The success of the search may depend upon several factors. The simple fact

that an ELT was aboard a missing aircraft does not necessarily guarantee that electronic search procedures will locate it because the unit may have become inoperative or the batteries totally discharged. Incident Commanders may attempt to maximize the search effort by conducting an electronic search and a general visual search simultaneously when weather and other circumstances permit.

NOTE: Since SARSAT/COSPAS satellites no longer monitor 121.5 MHz, we must rely on air- and ground-based monitoring (e.g., aircraft and FAA radios). CAP is still developing procedures on how it will respond to these reports, but we can expect these searches to take longer and be more manpower-intensive for both air and ground teams.

Additional Information

More detailed information and figures on this topic are available in Chapter 7 of the MART Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text.

Evaluation Preparation

Setup: Provide the student access to an aircraft ELT (or pictures).

Brief Student: You are a Mission Pilot trainee asked to describe how ELTs are detected and a search launched.

Evaluation

Performance measures:	Results	
1. Discuss the various types of ELTs.	P	F
2. Describe how an ELT is detected and a search is launched.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5003

Discuss Consideration Variables to Image Composition and Compose an Image

CONDITIONS

You are a sUAS Mission Pilot trainee and must demonstrate how to compose an image.

OBJECTIVES

Demonstrate image composition, particularly proper framing.

TRAINING AND EVALUATION

Training Outline

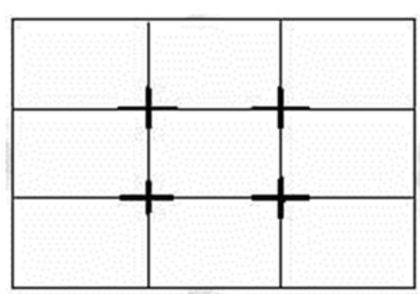
As a sUAS Mission Pilot/Technician trainee, knowledge of how to compose an image is essential.

1. Composition concerns how you arrange a subject in a picture and how you translate what your eyes see into a digital image. The key to composition is remembering that a digital camera doesn't "see" the same way that you do. How often have you taken a photo from an airplane, only to discover later that the image doesn't look anything like what you remember seeing? This is the first rule of photography – reality, as seen by your camera, is different from what you see with your eyes. If you frame all your photos without taking this into account, you will always get disappointing results.

   a. The *focal point* is the main subject of an image, such as a downed aircraft in a field or a breach in a levy. It is the main point that the viewer's eye will be drawn to when looking at the picture. This is why it is so important to know exactly what the customer wants to see in the images you will be taking on a particular sortie. If you don't know what you are supposed to be taking a picture of, it will be difficult or impossible to emphasize the right element in your images. This can lead to a disappointed customer, and that customer may decide CAP doesn't know what they're doing.

      As a general rule you only want a single focal point in an image. But sometimes the image will be required to show multiple focus points. For example, the customer may want to know the condition of two roads leading into a damaged power plant. In this case, you must compose the picture so that each road can be clearly seen.

   b. A useful rule to use in this case is the "Rule of Thirds," where you mentally draw two horizontal and two vertical lines through your viewfinder so that you have divided the scene into thirds. This breaks up your image into nine zones, with four interior corners where the lines intersect:



These four corners constitute the "sweet spots" in your picture. If you place a subject in any of these intersections, you'll usually end up with a satisfactory image. This holds true for a single focal point or with multiple focal points, as in our example above. In the case of a single focal point, such as the downed aircraft, placing the aircraft at any of these spots (or dead center) will result in a satisfactorily composed image.

2. *Filling the frame* is very important when taking a digital image. If the target is too small in the frame you lose important detail because you wasted a lot of pixels on extraneous details.

   You should always minimize the amount of dead (non-mission related) space in an image. Once you have decided on the focal point, don't relegate it to a small portion of the picture. In aerial photography, this is most easily accomplished with a combination of proper aircraft positioning, framing and use of the zoom lens. If you need to place the horizon in the image to establish perspective, never let the sky take up more than the top one-third of the image (note that this also satisfies the rule of thirds). And try to keep the horizon straight in the image.

   In CAP aerial photography, we try to follow three rules for framing:

   - Frame the image so the target fills most of the frame, but never more than 75% of the frame
   - Frame the image so no aircraft parts (i.e., landing gear, prop or prop guard) show; don't rely on imaging software to crop your image
   - Frame the target without using the zoom feature; only use the zoom to improve the framing or to concentrate on a specific portion of the target (e.g., damage to one section of a power plant or a crack in a bridge support)

   <u>Practice</u>

   An inexpensive way to practice framing is to take photos of objects from a vehicle. Preferably, have a friend drive along a freeway where you can safely drive ~ 55 mph; this most closely simulates the speed effect you'll experience during flight. Pick out "targets" of varying sizes along the roadway and photograph them, practicing the three rules for framing. After you get proficient at proper framing, take 2-3 photos of the same object as you pass; this also simulates what you'll be trying to accomplish while on imaging sorties.

Additional Information

More detailed information on this topic is available in Chapter 3 of the Airborne Photographer Reference Text.

Evaluation Preparation

Setup: The evaluation should be conducted with a digital camera-equipped sUAS and its user manual.

Brief Student: You are a sUAS Mission Pilot/Technician trainee asked how to compose an image.

Evaluation

<u>Performance measures</u>:	<u>Results</u>	
1. Demonstrate image composition, particularly proper framing.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-2205

Transfer Images to and View Images on a Computer

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must demonstrate how to transfer images to a computer and view images on a computer.

OBJECTIVES

Transfer several images to a computer. Select and view several images on a computer.

TRAINING AND EVALUATION

Training Outline

As a UAS Mission Pilot/Technician trainee, knowledge of how to transfer your images to a computer for review and future use is essential.

NOTE: Best practice is to set up a mission folder (mission number and date) before downloading the photos. In the newly-created mission folder, create two sub-folders: one for the original, untouched photos (e.g., RAW) and the other for photos (e.g., Sortie xxx Photos) you may manipulate (e.g., re-name or crop). Download your photos into the RAW folder, then copy them and paste them into the other folder. Having the untouched photos in the RAW folder will allow you to recover any photo that is accidently damaged or lost.

1. There are two ways to transfer images from a DJI digital camera onto a computer: attaching the aircraft directly to the computer (also known as tethering) or using a memory card reader.

   a. Using the DJI Phantom 4 Pro quadcopter as an example of tethering, Turn on the Phantom 4 Pro / Pro+ and connect a USB cable to the Camera Data Port to download photos and videos to a computer. The camera Micro SD card cannot be read when DJI Assistant 2 is being used.

   b. The easiest and most versatile way to import pictures into your computer is through a USB memory card reader that plugs into your computer; this allows fast and easy downloads from a camera's memory card. The best choice is a USB 2.0 card reader that accepts multiple types of cards.

      Some computers (laptops, in particular) come with slots that accept cards directly into the computer or via a PC card adapter. These features essentially function in the same way a card reader does, although much faster.

      Another advantage to a card reader is that it enables a crew to drop off their memory card and take the camera back out for another sortie, while the staff processes the images.

2. If you're using a USB cable, you can use your computer's file manager to drag-and-drop image files from the UAS's file location to the desired folder on the computer.

   If you're using a memory card reader, simply insert your card into the proper slot and the wizard will start.

   a. If the wizard asks which action you would like to perform, select "Always do the selected action."

b. Click “Copy pictures to a folder” and then click OK.

c. If you want to transfer all the photos in your aircraft (or on your memory card), click “Next.” If you want to choose which pictures to transfer, click “Clear All” and check the images you want to transfer (or just un-check the check boxes next to the photos you do not want to transfer), and then click “Next.”

d. The wizard puts your photos in the “My Pictures” folder on your computer unless you choose another location, which you should (see “Organizing Mission Images on a Computer” below). Choose the “Unedited Photos” sub-folder in the particular mission’s folder and click “Next.”

e. When the transfer is complete, select what you want to do next and click “Next.” If you chose nothing in the previous step, click “Finish.” The folder that contains your newly transferred photos opens.

3. If you have an image editing program installed on your computer it will step you through the process of transferring images from your camera or the camera’s media card (using a media card reader).

4. Most digital cameras show up as a removable drive in Explorer, so you can just click the drive letter to open the drive. Your pictures will probably be in a sub-folder rather than in the root of the drive. Drag the images onto the applicable “Unedited Photos” sub-folder on your hard drive to copy them.

5. Once transferred to your computer, your digital images become computer files. Review them to ensure they transferred successfully before you erase the images from your media card.

6. Image browsers are programs that help you view digital images in several different ways.

a. Remember that image browsers are designed to support only the photo formats they understand. In other words, they contain the necessary code to decompress a JPG photo, plus show a thumbnail and large preview, since they support the JPG format. When an all-purpose image browser comes up against a RAW file, chances are it won’t be able to display it (see “Editing RAW Images” in Chapter 7 for programs that will display RAW images).

b. Windows contains a basic image viewer and a simple editing program.

c. Most cameras, camcorders, printers and scanners include basic browser and/or editing programs. Most are easy to use and allow you to quickly review images on your hard drive (as well as download them directly from a digital camera) as moderate-sized thumbnails. They will normally enable you to rename photos, set up new folders, group photos into categories and do some simple processing.

d. Some basic browsers and/or editing programs can be downloaded from the Web. These programs support most file formats, have a thumbnail/preview function, allow batch renaming, and have basic editing features (e.g., cut or crop).

7. Image browsers allow you to quickly review the images from your sortie and determine if you captured all the images necessary to meet the mission's requirements. You can see if you captured images of the target from all required angles, that you properly framed and focused each image, and whether questionable conditions such as shadows, overcast or turbulence will necessitate another sortie.

Additional Information

More detailed information on this topic is available in Chapters 6 & 7 of the Airborne Photographer Reference Text.

Evaluation Preparation

Setup: The evaluation should be conducted with a UAS that has taken images or video, a computer and a media card reader. The evaluator should set up a folder on the computer to which the student will transfer photos.

Brief Student: You are a UAS Mission Pilot/Technician trainee asked to transfer images to and view images on a computer.

Evaluation

Performance measures:	Results	
1. Set up a mission folder with two sub-folders (RAW and another).	P	F
2. Transfer several images (into the RAW sub-folder) from a camera to a computer using the camera's cable and via a media card reader.	P	F
3. Copy the images into the other sub-folder. Demonstrate browsing images using a browser and/or editing program.	P	F
4. Describe what data must be recorded to complete the image processor datasheet.	P	F
5. Demonstrate how to view images on a computer.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5005

Discuss CAP Image / Graphic Requirements and Image & Orthomosaic Processing Software

CONDITIONS

You are an UAS Mission Pilot/Technician trainee and must discuss the typical graphics requirements for images. Additionally, the trainee must be aware of how still images will be used in computer programs that process the mission's images into products that were requested by the customer.

OBJECTIVES

Discuss image graphics requirements and the information needed to use the various Image Processing software applications.

TRAINING AND EVALUATION

Training Outline

CAP Airborne Photographers and UAS Pilots and Technicians have a variety of computer programs and applications that allow them to produce exceptional imagery products for the mission's customer. In recent years, the Federal Emergency Management Agency (FEMA) has relied upon CAP to quickly deliver high resolution imagery, both still and video, to support FEMA's disaster response efforts.

U.S. Air Force North (AFNORTH) currently requires the following information be added to an image that is delivered to a customer, unless the customer stipulates otherwise:

- Date in military format (03MAY19)
- Time over target in ZULU time (1030Z)
- Location of the image, including:
    - City and State
    - GPS coordinates in the format DDD, MM.M
    - A North pointing arrow annotated
    - CAP emblem annotated
- Name of the object in the image (Chalmette Refinery)

CAP Image Processing Program. A computer-based program was developed, called the CAP Image Processing Program, to permit the Airborne Photographer to "watermark" an image with the above data. Although the Image Processing Program was effective for the purpose, it lacked the ability to directly use the geocoded metadata that the camera system embeds in each image. There is no cost associated with this program.

An image watermarked by the CAP Image Processing Program is shown below.

RoboGEO. In recent years, a commercial computer program called RoboGEO is commonly used by CAP to produce watermarked images for our various customers. RoboGEO uses the image's geocoded metadata to automatically place AFNORTH's required data directly on the still image. As a commercial program, RoboGEO costs approximately $70 to purchase. Site licenses can be purchased for a reduced price per user. An example of a RoboGEO watermarked image is shown below:

Geo-rectified Orthomosaic Images. With the great development of professional-level drones in recent years, manufactures have produced remotely controlled aircraft and cameras that inexpensively facilitate the production of geo-rectified orthomosaic images consisting of dozens or hundreds of individual images that are electronically "stitched together" to produce a single, high resolution image that will be of considerable value to the customer.

CAP presently uses the following software programs to produce geo-rectified orthomosaic imagery:

- DJI Ground Station Pro. This is the free tablet/phone application produced by DJI, a Chinese company, that allows a pilot to create a precise flight plan that the DJI UAS (Phantom, Mavic, Inspire, etc.) uses to autonomously capture a large number of geocoded images. These images are then imported into another program to produce an orthomosaic image.

- Mission Planner. Mission Planner is free open-source ground control software created by a community of software developers called ArduPilot. The Mission Planner software program runs on a computer, usually a laptop, which permits point-and-click interaction with the UAS hardware, custom scripting, and simulation. Some of CAP's UAS aircraft (F-800, E-384, Endurance) are autonomously flown with Pixhawk controllers which require software not produced by DJI.

- Metashape. Agisoft Metashape, now known as formerly known as Photoscan, is a commercial, stand-alone software product that performs photogrammetric processing of digital images and generates 3D spatial data to be used in GIS applications, cultural heritage documentation, and visual effects production as well as for indirect measurements of objects of various scales. Metashape Standard costs approximately $180 for the standard edition that CAP uses during training at NESA. This is the software that electronically "stitches" the UAS images together to produce an orthomosaic image. Depending on the desired resolution, this software may take many hours to produce the orthomosaic.

- QGIS. QGIS is a free and open-source cross-platform desktop geographic information system (GIS) application that supports viewing, editing, and analysis of geospatial data. QGIS functions as geographic information system (GIS) software, allowing users to analyze and edit spatial information, in addition to composing and exporting graphical maps. QGIS supports both raster and vector layers; vector data is stored as either point, line, or polygon features. Multiple formats of raster images are supported, and the software can georeference images.

- Pix4D. Pix4D is a Swiss company which started in 2011 and develops a suite of software products that use photogrammetry and computer vision algorithms to transform DSLR, fisheye, RGB, thermal and multispectral images into 3D maps and 3D modeling. CAP has purchased a perpetual educational license for Pix4D to allow pilots and technicians to learn how to produce geo-rectified orthomosaic images from the UAS camera. In the case of Pix4D, the UAS images are uploaded to the Pix4D file servers where the production of the high-resolution 2D and 3D maps and models takes place.

Additional Information

Information and instructions on how to use the applications described above will be provided at a later time as annexes to this publication. At the present time, in-depth classes on these applications are provided during the Advanced sUAS Course conducted at CAP's National Emergency Services Academy (NESA) each year during July.

Evaluation Preparation

Evaluation

Performance measures:	Results	
1. Discuss the information required to be displayed, or "watermarked" on CAP images.	P	F
2. Discuss the various computer- and tablet-based applications used by CAP to produce geo-rectified orthomosaic map products for a customer.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5006

Prepare an Orthomosaic Image Utilizing Orthomosaic Image Processing Software

CONDITIONS

You are an UAS Technician trainee and must demonstrate your ability to prepare a mosaic image from UAS aerial photography or videography using Microsoft Image Composite Editor (ICE).

OBJECTIVES

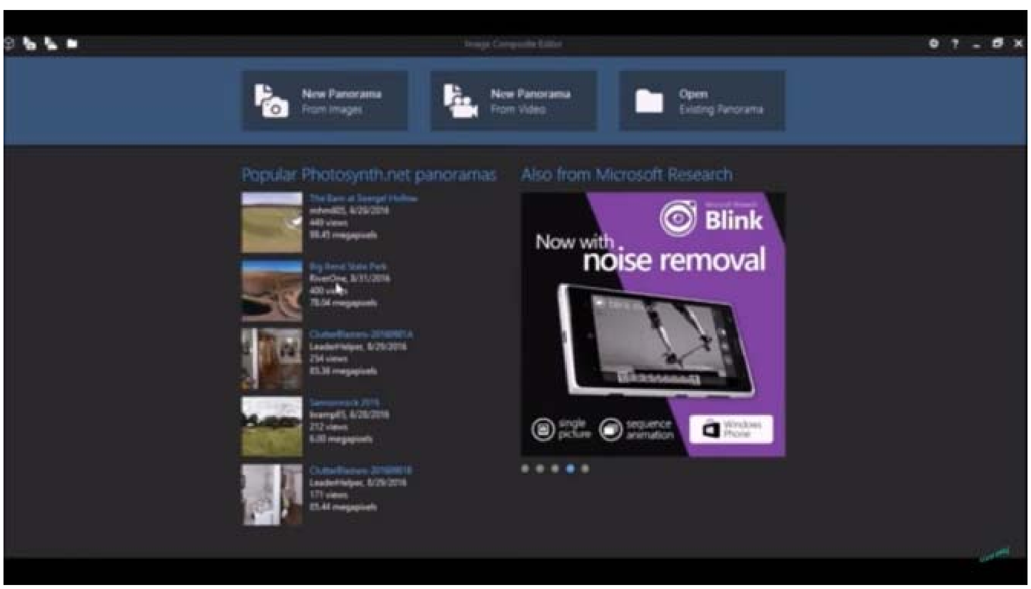
Prepare a mosaic image from UAS aerial photography or videography using Microsoft Image Composite Editor (ICE).

TRAINING AND EVALUATION

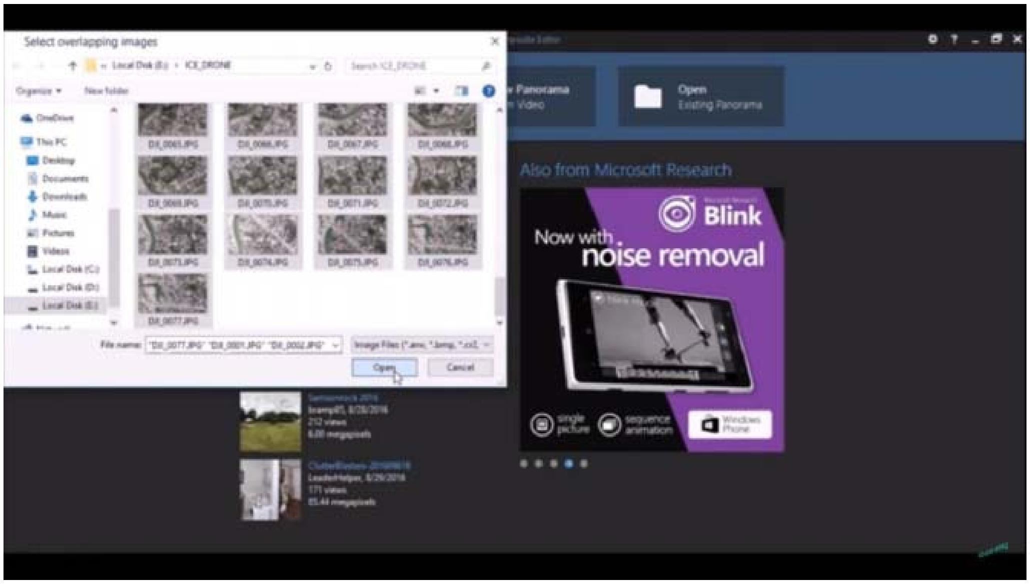
Training Outline

1. Although Microsoft ICE is not normally used by CAP for delivering a geo-rectified orthomosaic map to the customer, it is a valuable tool in the field to determine if the imagery captured by the UAS is accurate and useful. The ability to quickly produce an orthomosaic of reasonable quality to inform an Incident Commander of current ground conditions in a target area can be extremely useful. There is no cost to use Microsoft ICE.

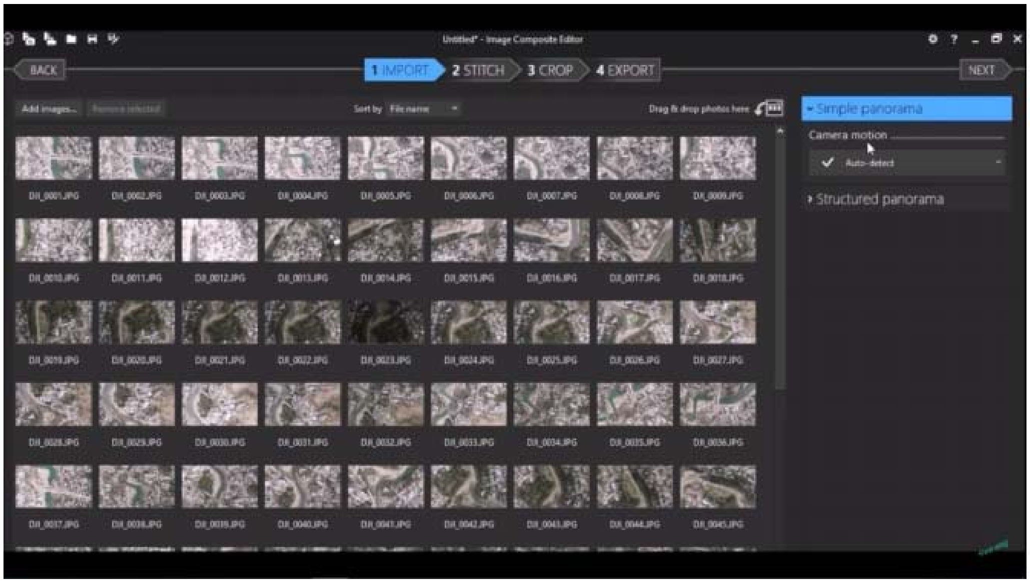
You will install an appropriate version of Microsoft ICE for your computer and, after having flown a UAS mission and collected still images or video of your search objectives, you will launch ICE and see the following screen. Three options appear at the top of the screen: “New Panorama from Images”, “New Panorama from Video”, and “Open Existing Panorama”. You will load the aerial photos from your Memory card to a directory on your computer.



2. Then you will select the first option: “New panorama from Images”. It will prompt you to name the folder containing your images. When you do that it will load your whole directory of images. Make sure there are no outliers or irrelevant images in that directory, or files from another flight. This is what the screen will look like when you browse to the folder containing your aerial photos.



3. This is what it will look like after your images are loaded into ICE. At the top of the screen are four tabs that indicate progress and status. After importing your files, click on the second step which is “Stitch” and your images will be stitched together into a mosaic.



4. When stitching is complete ICE will show you the mosaic image. It contains the full very high resolution of all of you combined high res images.

5. In the third mode, Cropping, you can pan and scroll and zoom around the image mosaic, crop it if you want to, and rotate it for different perspectives.

6. Your final option is to save and export the mosaic image. You can export it in many different image formats and keep the full resolution or scale and compress it down to reduce size.

Additional Information

More detailed information on Microsoft ICE is available in the Microsoft documentation and website.

Evaluation Preparation

Setup: Provide the student with a directory of aerial photos, or allow them to collect their own images, and software for installation of ICE.

Brief Student: You are a UAS Technician trainee asked to demonstrate the creation of a mosaic image from a large number of very high resolution aerial photos.

Evaluation

Performance measures:	Results	
1. Install Microsoft ICE on your computer.	P	F
2. Load your aerial photos to your computer and import them to ICE.	P	F
3. Stitch your images together into an image mosaic.	P	F
4. View your mosaic and crop it if you wish.	P	F
5. Export your image in a format to share it with others.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5007

Demonstrate Proper Use, Charging, Maintenance, and Shipping of UAS Battery Systems

CONDITIONS

You are a Mission Pilot or UAS Technician trainee and must know how to keep camera accessories and GPS systems mission ready.

OBJECTIVES

Discuss UAS camera function, operations, and maintenance concerns.

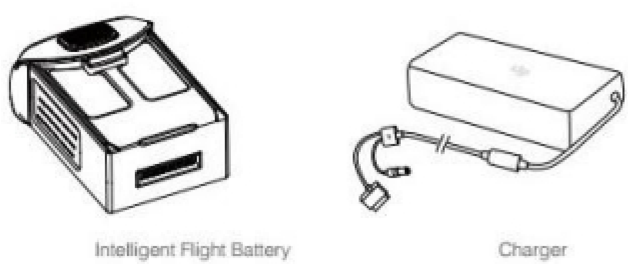
TRAINING AND EVALUATION

Training Outline

1. The power source for your UAS is a Lithium Polymer (LiPo) battery. In the case of the DJI Phantom 4 Pro, the battery is an intelligent battery with a capacity of about 6000 mAH and a voltage of 15.2 volts. It is intelligent because of its smart charge/discharge technology and it has visual LED indicators that display battery status and other features described below:

DJI Intelligent Flight Battery

The DJI Intelligent Flight Battery has a capacity of 5870 mAh, a voltage of 15.2 V, and a smart charge/discharge functionality. It should only be charged using an appropriate DJI approved charger.

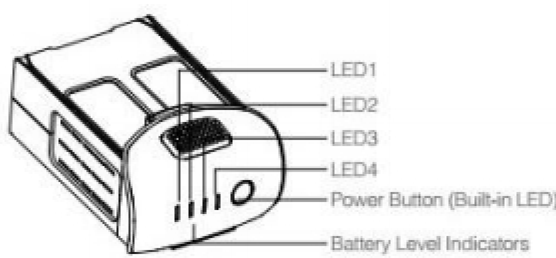


DJI Intelligent Flight Battery Functions

1. Battery Level Display: The LED indicators display the current battery level.
2. Auto-Discharging Function: To prevent swelling, the battery automatically discharges to below 65% of total power when it is idle for more than ten days. It takes around two days to discharge the battery to 65%. It is normal to feel moderate heat being emitted from the battery during the discharge process. Discharge thresholds can be set in the DJI GO 4 app.
3. Balanced Charging: Automatically balances the voltage of each battery cell when charging.
4. Overcharge Protection: Charging automatically stops when the battery is fully charged.
5. Temperature Detection: The battery will only charge when the temperature is between 5°C (41°F) and 40°C (104°F).
6. Over Current Protection: The battery stops charging when a high amperage (more than 8 A) is detected.
7. Over Discharge Protection: To prevent over-discharge damage, discharging automatically stops when the battery voltage reaches 12 V.
8. Short Circuit Protection: Automatically cuts the power supply when a short circuit is detected.
9. Battery Cell Damage Protection: The DJI GO 4 app displays a warning message when a damaged battery cell is detected.
10. Sleep Mode: To save power, the battery enter sleep mode after 20 minutes of inactivity.
11. Communication: Information pertaining to the battery's voltage, capacity, current, etc. is transmitted to the aircraft's main controller.

2. To use the battery, you will press the button once, then again hold it for 2 seconds to turn it on. The lights will display the battery level. To turn the battery off, you will press the button once, then again hold it for 2 seconds to turn it off.

Using the Battery



Turning ON/OFF

Turning On: Press the Power Button once, then press again and hold for 2 seconds to turn on. The Power LED will turn green and the Battery Level Indicators will display the current battery level.

Turning Off: Press the Power Button once, then press again and hold for 2 seconds to turn off. The battery power LED will flash when powering off the Phantom to allow automatically stopping of a recording during the event recording wasn't stopped.

3. You can check the battery level in percentages of full by reading the LED light display as shown in the following table:

Checking the Battery Level

The Battery Level Indicators display how much power remains. When the battery is turned off, press the Power Button once. The Battery Level Indicators will light up to display the current battery level. See below for details.

The Battery Level Indicators will also show the current battery level during charging and discharging. The indicators are defined below.

▯ : LED is on. ⁞▯⁞ : LED is flashing.
▯ : LED is off.

Battery Level Indicators				
LED1	LED2	LED3	LED4	Battery Level
▯	▯	▯	▯	87.5%~100%
▯	▯	▯	⁞▯⁞	75%~87.5%
▯	▯	▯	▯	62.5%~75%
▯	▯	⁞▯⁞	▯	50%~62.5%
▯	▯	▯	▯	37.5%~50%
▯	⁞▯⁞	▯	▯	25%~37.5%
▯	▯	▯	▯	12.5%~25%
⁞▯⁞	▯	▯	▯	0%~12.5%
▯	▯	▯	▯	=0%

4. Special care must be taken when the battery is used at low temperatures. Capacity is significantly reduced in cold temperatures. Keep the battery indoors or warm before you use it in cold weather. Expect less range, performance and time from batteries in cold weather.

Low Temperature Notice:

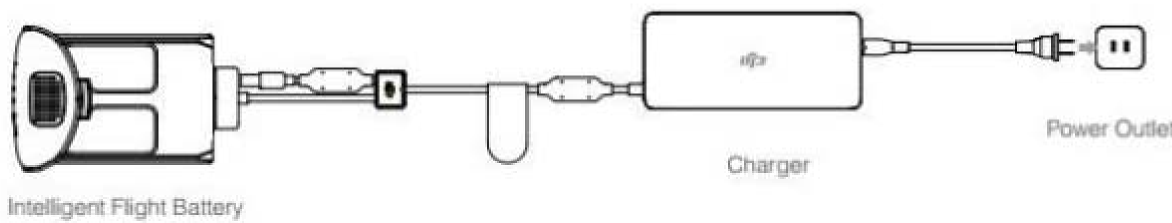
1. Battery capacity is significantly reduced when flying in low temperature (< 0°C) environments.
2. It is not recommended that the battery be used in extremely low temperature (< -10°C) environments. Battery voltage should reach the appropriate level when operating environment with temperatures between -10°C and 5°C.
3. End the flight as soon as the DJI GO 4 app displays the "Low Battery Level Warning" in low temperature environments.
4. Keep the battery indoors to warm it before flying in low temperature environments.
5. To ensure optimal performance of the battery, keep the battery temperature above 20°C.
6. The charger will stop charging the battery if the battery cell's temperature is not within the operating range (0°C ~ 40°C).

5. To charge your battery, follow the steps and the illustration below.

Charging the Intelligent Flight Battery

1. Connect the Battery Charger to a power source (100-240 V 50/60 Hz).
2. Connect the Intelligent Flight Battery to the Battery Charger to start charging. If the battery level is above 95%, turn on the battery before charging.
3. The Battery Level Indicator will display the current battery level as it is charging.
4. The Intelligent Flight Battery is fully charged when the Battery Level Indicators are all off.
5. Air-cool the Intelligent Flight Battery after each flight. Allow its temperature to drop to room temperature before storing it for an extended period.

⚠ • Always turn off the battery before inserting it or removing it from the Phantom 4 Pro / Pro+. Never insert or remove a battery when it is turned on.



6. The intelligent battery is capable of providing warnings and diagnostic messages when problems are encountered. Be aware of these messages to protect your battery and UAS.

Battery Protection LED Display

The table below shows battery protection mechanisms and corresponding LED patterns

How to discharge your Intelligent Flight Battery:

Slow : Place the Intelligent Flight Battery into the Phantom 4's Pro / Pro+ Battery Compartment and turn it on. Leave it on until there is less than 8% of power left, or until the battery can no longer be turned on. Launch the DJI GO 4 app to check battery levels.

Rapid : Fly the Phantom 4 Pro / Pro+ outdoors until there is less than 8% of power left, or until the battery can no longer be turned on.

				LED3 blinks three times per second	Over-voltage charger detected
				LED4 blinks twice per second	Charging temperature is too low
				LED4 blinks three times per second	Charging temperature is too high

After these issues are resolved, press the Power Button to turn off the Battery Level Indicator. Unplug the Intelligent Flight Battery from the charger and plug it back in to resume charging. Note that you do not need to unplug and plug in the charger in the event of a room temperature error; the charger will resume charging when the temperature is within the allowable range.

7. In order to extend its life, your battery should be discharged before storage and recharged before use as described below:

8. When not in use, or being transported, your battery should be stored in a fireproof bag or box. LiPo batteries can create dangerous fires when over charged, rapidly discharged, shorted, or physically damaged. If you see signs of swelling or cracking in your battery case, replace the batteries and dispose properly of them.

Additional Information

For more detailed information on the DJI P4P Camera and for optical and electronic specifications please consult the DJI P4P User Manual.

Evaluation Preparation

Provide the student with a P4P intelligent LiPo battery.

Evaluation

Performance measures: Results

1.	Power up the battery and identify the battery status lights	P	F
2.	Describe the current capacity of the battery and estimate voltage	P	F
3.	Power off the battery - find the battery log	P	F
4.	Describe proper care, storage, and protection of battery	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-2024

Demonstrate Use of Sectional Charts

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must use the information displayed on an aeronautical sectional chart and understand the information that the chart provides.

OBJECTIVES

Demonstrate use of the information displayed on a sectional chart and to determine heading and distance. Show familiarity with CAP Grids and symbols used on Sectional Charts. Determine whether an Aeronautical Chart is current or not. Understand scale used on Aeronautical Charts.

TRAINING AND EVALUATION

Training Outline

1. As a Mission sUAS Mission Pilot/Technician trainee, basic knowledge the information contained on a sectional chart and its use is essential. The most important tool you will use in both mission flight planning and execution is the chart. Highway road maps are usually not acceptable for air operations, since most don't have detailed terrain depiction and also lack the superimposed reference system. Many aeronautical charts have such small scales that the makers are unable to show required levels of detail when trying to put a large area into a small chart space. The most useful chart that has been widely accepted for visual, low-altitude navigation is the sectional aeronautical chart, sometimes simply referred to as the "sectional". Refer to Chapter 8 of the Mission Scanner Reference Text for figures associated with the following topics.
2. Sectional chart. Sectionals use a scale of one to five hundred thousand, or 1:500,000, where all features are shown 1/500,000 of their actual size (1 inch = 6.86 nm). This allows accurate depiction of both natural and cultural features without significant clutter. Sectionals portray the following:
   a. Physical, natural features of the land, including terrain contours or lines of equal elevation.
   b. Man-made or cultural development, like cities, towns, towers, and racetracks.
   c. Visual and radio aids to navigation, airways, and special-use airspace.
   d. Airports and airport data, lines of magnetic variation, controlled airspace, obstructions and other important information.
   e. VFR waypoints.
   f. Obstructions to flight.

3. Legend. An often overlooked but vital part of the sectional is the 'Legend.' This is a written explanation of symbols, projections, and other features used on the chart. Other important areas of the chart are its title page or "panel", and the margins around the chart edges. The margins contain supplemental radio frequency information, details about military or special use airspace, and other applicable regulations. The title panel identifies the region of the country shown by the chart, indicates the scale used in drawing the chart, explains elevations and contour shading, and shows the expiration date of the chart and effective date of the next issue of that chart. It is vitally important that you keep current charts with you at all times.

4. Interpretation. A significant part of air navigation involves interpreting what one sees on the chart, then making comparisons outside the aircraft. Basic chart symbols can be grouped into cultural features, drainage features, and relief features.

   Understanding cultural features is straightforward, and they usually require little explanation. Villages, towns, cities, railroads, highways, airports or landing strips, power transmission lines, towers, mines, and wells are all examples of cultural features. The chart legend explains the symbols used for most cultural features, but if no standard symbol exists for a feature of navigational significance, the cartographer frequently resorts to printing the name of the feature itself, such as factory or prison, on the chart.

Drainage features on charts include lakes, streams, canals, swamps, and other bodies of water. On sectional charts these features are represented by lightweight solid blue lines for rivers and streams; large areas of water, such as lakes and reservoirs, are shaded light blue with the edges defined by lightweight solid blue lines. Under most conditions, the drainage features on a map closely resemble the actual bodies of water. However, certain bodies of water may change shape with the season, or after heavy rains or drought. Where this shape change occurs with predictability, cartographers frequently illustrate the maximum size expected for a body of water with light-weight, blue, dashed lines. If you intend to use drainage features for navigation, you should consider recent rains or dry spells while planning and remember the body of water may not appear exactly as depicted on the chart.

Relief features indicate vertical topography of the land including mountains, valleys, hills, plains, and plateaus. Common methods of depicting relief features are contour lines, shading, color gradient tints, and spot elevations. Contour lines are the most common method of depicting vertical relief on charts. The lines do not represent topographical features themselves, but through careful study and interpretation, you can predict a feature's physical appearance without actually seeing it. Each contour line represents a continuous imaginary line on the ground on which all points have the same elevation above or below sea level, or the zero contours. Actual elevations above sea level of many contour lines are designated by a small break in the line, while others are not labeled. Contour interval, or vertical height between each line, is indicated on the title panel of sectionals. Contour lines are most useful in helping us to visualize vertical development of land features. Contour lines that are grouped very closely together indicate rapidly changing terrain, such as a cliff or mountain. More widely spaced lines indicate more gentle slopes. Absence of lines indicates flat terrain. Contour lines can also show changes in the slope of terrain.

Shading is added to sectional charts to help highlight and give contrast to the contour lines. These tiny gray dots are applied adjacent to selected contour lines and give the contours a three-dimensional appearance. This makes it easier to imagine the physical appearance of the shaded topographical feature. Gradient tints, the "background" colors on charts, indicate general areas of elevation. The height range assigned to each gradient color is indicated on the title panel of each sectional chart. Areas that are near sea level are pale green, while high terrain is color-coded a deep red/brown. Intermediate elevations are indicated by brighter shades of green, tan, or lighter shades of red/brown.

5. Aeronautical data. The aeronautical information on the sectional charts is for the most part self-explanatory. An explanation for most symbols used on aeronautical charts appears in the margin of the chart. Additional information appears at the bottom of the chart.

   Information concerning very high frequency (VHF) radio facilities such as tower frequencies, omnidirectional radio ranges (VOR), and other VHF communications frequencies is shown in blue. A narrow band of blue tint is also used to indicate the centerlines of Victor Airways (VOR civil airways between omnirange stations). Low frequency-medium frequency (LF/MF) radio facilities are shown in magenta (purplish shade of red).

   Runway patterns are shown for all airports having permanent hard surfaced runways. These patterns provide for positive identification as landmarks. All recognizable runways, including those that may be closed, are shown to aid in visual identification. Airports and information pertaining to airports having an airport traffic area (operating control tower) are shown in blue. All other airports and information pertaining to these airports are shown in magenta adjacent to the airport symbol that is also in magenta.

The symbol for obstructions is another important feature. The elevation of the top of obstructions above sea level is given in blue figures (without parentheses) adjacent to the obstruction symbol. Immediately below this set of figures is another set of lighter blue figures (enclosed in parentheses) that represent the height of the top of the obstruction above ground-level. Obstructions which extend less than 1,000 feet above the terrain are shown by one type of symbol and those obstructions that extend 1,000 feet or higher above ground level are indicated by a different symbol (see sectional chart). Specific elevations of certain high points in terrain are shown on charts by dots accompanied by small black figures indicating the number of feet above sea level.

The chart also contains larger bold face blue numbers that denote Maximum Elevation Figures (MEF). These figures are shown in quadrangles bounded by ticked lines of latitude and longitude, and are represented in thousands and hundreds of feet above mean sea level. The MEF is based on information available concerning the highest known feature in each quadrangle, including terrain and obstructions (e.g., trees, towers, and antennas). Since CAP aircraft regularly fly at or below 1000' AGL, aircrews should exercise extreme caution because of the numerous structures extending up as high as 1000' – 2000' AGL. Additionally, guy wires that are difficult to see even in clear weather support most truss-type structures; these wires can extend approximately 1500 feet horizontally from a structure. Therefore, all truss-type structures should be avoided by at least 2000 feet (horizontally and vertically).

6. Determining heading and distance. To determine a heading, locate the departure and destination points on the chart and lay the edge of a special protractor, or plotter, along a line connecting the two points. Read the true course for this leg by sliding the plotter left or right until the center point, or grommet, sits on top of a line of longitude. When the course is more to the north or south, you can measure it by centering the grommet on a parallel of latitude, then reading the course from the inner scale that's closer to the grommet. To determine distance, use the scale that's printed on the plotter's straight edge: one edge measures nautical miles and the other statute miles.

7. Grids. CAP has adopted a standard grid system built upon the matrix of parallels of latitude and meridians of longitude and the sectional aeronautical chart. Sectional charts cover a land area approximately seven degrees of longitude in width and four degrees of latitude in height. Information pertaining to gridding can be found in Attachment E of the U.S. National SAR Supplement to the International Aeronautical and Maritime SAR Manual (or Attachment 1 of the Mission Aircrew Reference Texts).

   The sectional grid system used by Civil Air Patrol divides each sectional's area into 448 smaller squares. This process begins by dividing the whole area into 28 1-degree grids, using whole degrees of latitude and longitude. Then each 1-degree grid is divided into four 30-minute grids, using the 30-minute latitude and longitude lines. Finally, each of the 30-minute grids is divided into four 15-minute grids, using the 15- and 45-minute latitude and longitude lines.

   When circumstances require, a 15-minute grid can be divided into four more quadrants using 7 1/2 degree increments of latitude and longitude, creating four equal size grids that are approximately 7 1/2 miles square. The quadrants are then identified alphabetically - A through D - starting with the northwest quadrant as A, northeast as B, southwest as C and southeast as D. [If needed, a 7 1/2 degree grid can be further subdivided into four quadrants using the same methodology: using the 7 1/2 degree grid 'A', the quadrants would be labeled AA, AB, AC and AD.]

   Another means of designating a grid system is the Standardized Latitude and Longitude Grid System. It has an advantage over the sectional standardized grid in that it can be used on any kind of chart that has lines of latitude and longitude already marked. In this system, 1-degree blocks are identified by the intersection of whole numbers of latitude and longitude, such as 36-00N and 102-00W: these points are always designated with the latitude first, such as 36/102, and they identify the area north and west of the intersection of these two lines. Next, the 1-degree grid is divided into four quadrants using the 30-minute lines of latitude and longitude. Label each quadrant A through D; the northwest quadrant being 36/102A, the northeast 36/102B, the southwest 36/102C, and the southeast 36/102D. Each quadrant can also be divided into four sub-quadrants, labeled AA, AB, AC, and AD, again starting with the most northwest and proceeding clockwise.

Additional Information

More detailed information and pictures on this topic are available in Chapter 8 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Setup: Provide the student with a sectional chart and a plotter (if available.)

Brief Student: You are a Scanner trainee asked to discuss the information displayed on a sectional chart and use the information to determine heading and distance.

Evaluation

Performance measures:	Results	
1. Identify and discuss the following on an aeronautical sectional chart:	P	F
a. Physical features such as topographical details.		
b. Towns, cities, highways, roads, and towers (MSL and AGL).		
c. Airways, radio aids, airports and airport data.		
d. Maximum Elevation Figures.		
e. Legend and margin information.		
2. Given a sectional and plotter, determine a heading and measure distances.	P	F
3. State the size of a full and one-quarter CAP and Standardized grids.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5009

Demonstrate the Ability to Initiate Emergency Procedures for a Lost Link, Battery Failure, or Other In-flight Emergency

CONDITIONS

You are a UAS Mission Pilot or UAS Technician trainee and must demonstrate the ability to initiate emergency procedures for in-flight emergencies on UAS operations.

OBJECTIVES

Initiate appropriate procedures for a lost control link, battery failure, or other in-flight emergency.

TRAINING AND EVALUATION

Training Outline

There are four parts to each of the following Emergency Scenarios:

1. **Potential Incident Title & Symptom(s) –** For the title, name the scenario that may be encountered and detail what may be included in the specific scenario.
2. **Pilot Response –** Include immediate action required by the pilot to reduce risk to a point that's ALARP. Structure points with the highest to the lowest priority.
3. **Crew Response –** Detail the immediate action of the crew to reduce the risk to the lowest point possible. As above, structure points from highest to lowest importance.
4. **Post Incident Action –** Detail the requirements following the incident, again with a high to low priority. This will usually include the statement "Follow the incident reporting tool."

Scenario 1 - Loss of Aircraft Control - Aircraft not responding to pilot's control or the aircraft is operating independently from the pilot's control

- Change the aircraft's Flight Mode to Attitude (ATTI) mode and try to regain control
- If control is not restored, activate the aircraft's Return to Home (RTH). Check whether the mode is functional and/or if the control of the aircraft has been regained
- Turn off and on the controller and try to recover control of the aircraft
- If safe to do so, attempt to power off the motors
- If aircraft flyaway continues, note aircraft battery life, height, speed and heading
- Retain VLOS with the aircraft for as long as possible
- If required, inform the emergency services
- Follow the incident reporting tool

Scenario 2 – Battery Failure During Flight - Power to aircraft unavailable, Aircraft not responding to pilot's control. Aircraft falling from the sky.

- Notify aircrew of emergency
- Clear the immediate area - Observers call out

- Blast siren, whistle, or use megaphone to alert all participants
- Maintain VLOS with falling aircraft
- Clear the immediate area
- Notify anyone in aircraft's path
- Assess physical damage to aircraft, property, people
- Render first aid - seek medical treatment
- Complete Incident reporting and any required notifications

Scenario 3 - Pilot is Unwell or Incapacitated - Pilot incapacitation should be avoided at all cost by using systems such as the 'IMSAFE' model, however, incidents can occur.

- If able, warn the crew of your status
- Check the area is clear and activate the RTH
- Follow the instructions of the pilot
- If the pilot is unable to, ensure the landing area is clear and activate the RTH
- Monitor the aircraft until it has landed and shut down before attending to the pilot
- If required, inform the emergency services
- Follow the incident reporting tool

Scenario 4 - Public Enters Flying Area - Prior to every flight, the pilot and crew should ensure the area is clear. Using signs and having spotter will help avoid public entering the flight location. Each stage of this flowchart model should be structured highest to lowest priority.

- If the individual is further than 30m from the landing site, the pilot should land immediately
- If the individual is within 30m of the landing site, the pilot should select an alternate site to safely land
- Immediately notify the pilot of the member of the public in the flight area
- Inform the member of the public they're in the flight area and request they remain in position to enable the pilot to safely land the aircraft
- If required, assist the pilot with locating a new landing area with the required separation distance. Clearly guide the pilot to this location
- If required, inform the emergency services
- Follow the incident reporting tool

Additional Information

Consult the UAS manufacturer's User Manual or Flight Manual for additional information on emergency flight procedures

Evaluation Preparation

Setup: Provide the student with a UAS and flying field.

Brief Student: You are a UAS Mission Pilot or UAS Technician trainee asked to discuss the procedures to respond to in-flight emergencies.

Evaluation

<u>Performance measures:</u> <u>Results</u>

1.	Describe pilot actions, crew actions, and follow up actions for several potential In-flight emergency scenarios	P	F
2.	Discuss how to avoid in flight emergencies	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly

O-5011

Demonstrate Scanning Patterns and Locate Targets

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must use scanning patterns to locate targets.

OBJECTIVES

Use proper scanning patterns to locate an object and a person on the ground.

TRAINING AND EVALUATION

Training Outline

1. As a sUAS Mission Pilot/Technician trainee, the ability to use proper scanning patterns to locate objects on the ground is essential. Scanning is the process of investigating, examining, or checking by systematic search. In search and rescue operations, the scanner visually searches for distress signals or accident indications by using a systematic eye movement pattern. Refer to Chapter 5 of the Mission Scanner Reference Text for figures.

2. Vision. The brain actively senses and is aware of everything from the point outward to form a circle of 10 degrees (visual acuity outside of this cone of vision is only ten percent of that inside the cone). This is central vision, produced by special cells in the fovea portion of the eye's retina. Whatever is outside the central vision circle also is "picked up" by the eyes and conveyed to the brain, but it is not perceived clearly. This larger area is called peripheral vision; cells less sensitive than those in the fovea produce it. For example, an object that is visible one mile away using central vision would only be visible 500 feet away using peripheral vision. However, objects within the peripheral vision area can be recognized if mental attention is directed to them.

   Note that peripheral vision is very important at night and is also important in picking up structures such as towers.

3. Fixation area. The fixation area is the area in which "concentrated" looking takes place. If the search objective happens to come within this fixation area, you probably will recognize it. For central vision to be effective, the eye must be focused properly. This focusing process takes place each time the eyes, or head and eyes, are moved. When you are not actively focusing while looking outside the aircraft, your focal point will be a point about 30 feet out. Thus, daydreaming or thinking about other things while you are supposed to be looking for the target will guarantee you will not see the target even if your eyes are pointed right at it!

4. Fixation points and lines of scan. When you wish to scan a large area, your eyes must move from one point to another, stopping at each point long enough to focus clearly. Each of these points is a fixation point. When the fixation points are close enough the central vision areas will touch or overlap slightly. Spacing of fixation points should be 3 or 4 degrees apart to ensure the coverage will be complete. Consciously moving the fixation points along an imaginary straight line produces a band of effective "seeing."

5. Fixation area. The goal of scanning techniques is to thoroughly cover an assigned search area. Reaching this goal on a single overflight is not possible for a number of reasons. First, the eye's fixation area is a circle and the search area surface (ground) is flat. Coverage of a flat surface with circles requires much overlapping of the circles. This overlapping is not possible on a search mission because of the aircraft's motion. Also, the surface area covered by the eye's fixation area is less for the area near the airplane and increases with distance from the airplane. The net result is relatively large gaps in coverage near the airplane and some overlap as distance from

the airplane increases. Angular displacement is the angle formed from a point almost beneath the airplane outward to the scanning range, or beyond. By this definition, the horizon would be at 90 degrees displacement. Although the fixation area may be a constant 10-degree diameter circle, the effectiveness of sighting the objective decreases with an increase in this angular displacement. Said another way, your ability to see detail will be excellent at a point near the aircraft, but will decrease as the angular displacement increases. At the scanning range, at which the angular displacement may be as much as 45 degrees, the resolution of detail area probably will have shrunk to a 4-degree diameter circle. This is why having scanners looking out both sides of the aircraft is optimal. With track spacing (explained later) proper for the given search visibility, each scanner will look at roughly the same area (i.e., double coverage).

6. Field of scan. The area that you will search with your eyes in lines of scan is called the field of scan. The upper limit of this field is the line that forms the scanning range. The physical limit of the viewing area on a tablet or computer screen will determine the size of field of scan.

7. Scanning range. We are using the term "scanning range" to describe the distance from an aircraft to an imaginary line parallel to the aircraft's ground track (track over the ground.) This line is the maximum range at which a scanner is considered to have a good chance at sighting the search objective.

   Scanning range sometimes may be confused with search visibility range. Search visibility range is that distance at which an object the size of an automobile can be seen and recognized. Aircraft debris may not be as large as an automobile and may not be immediately recognizable as aircraft debris, particularly when the aircraft is flying at a higher rate of speed. Therefore, scanning range may be less than but never greater than the search visibility.

8. Scanning patterns. To cover the field of scan adequately requires that a set pattern of scan lines be used. Research into scanning techniques has shown that there are two basic patterns that provide the best coverage. These are called the diagonal pattern and the vertical pattern. The diagonal pattern is the better of the two.

   The diagonal pattern begins with the first fixation point slightly forward of the aircraft's position, and the scanner moves her fixation points sequentially back toward the aircraft. The next scan line should be parallel to the first, and so on. Each succeeding scan line is started as quickly as possible after completing the previous one. Remember, the duration of each fixation point along a scan line is about 1/3 second: how long it takes to complete one scan line depends on the distance at which the scanning range has been established. Also, the time required to begin a new scan line has a significant influence on how well the area nearest the airplane is scanned. In other words, more time between starting scan lines means more space between fixation points near the airplane.

Additional Information

More detailed information and pictures on this topic are available in Chapter 5 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Setup: Provide the student with images and video taken from a UAS that can be viewed on a tablet or computer screen. The sample images should contain moving vehicles and people, as well as small objects on the ground.

Brief Student: You are a Scanner trainee asked to demonstrate scanning patterns and locate targets in a search area.

Evaluation

Performance measures	Results	
1. Define "scanning" and "fixation," and describe how aircraft motion effects scanning.	P	F
2. Demonstrate knowledge of central and peripheral vision and describe where your point is when your eyes are relaxed.	P	F
3. Demonstrate knowledge of fixation points and lines of scan, and define "scanning range."	P	F
4. Demonstrate diagonal and vertical scanning patterns.	P	F
5. Locate a target in a search area.	P	F
6. Locate a person in a search area.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-2023

Demonstrate Techniques to Reduce Fatigue

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must demonstrate and discuss how to minimize fatigue.

OBJECTIVES

Demonstrate techniques to minimize fatigue, and how you would maintain visual contact with the aircraft during flight.

TRAINING AND EVALUATION

Training Outline

1. As a sUAS Mission Pilot/Technician trainee, knowing how to minimize fatigue is essential. The art of maintaining visual contact is more physically demanding and requires greater concentration than mere sight seeing. In order to maintain visual contact effectiveness, you must be aware of your own fatigue level. The following can help maintain visual contact effectiveness:
   a. Find a comfortable position and move around to stretch when necessary.
   b. At night, use red lights for illumination to prevent loss of night vision.
   c. Focus on a close object (like a nearby tree or building in the line of view of the aircraft) on a regular basis. The muscles of the eye get tired when you focus far away for an extended period of time.
   d. Rest during periods of inactivity.

2. The "clock position" system is used to describe the relative positions of everything around your position, with the location of the aircraft being "12 o'clock." The system considers positions to be on a horizontal plane that is centered around your control position, and any object above or below this plane is either "high" or "low."

Additional Information

More detailed information on this topic is available in Chapter 5 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Setup: Provide the student access to an aircraft (may simulate on the ground).

Brief Student: You are a sUAS Mission Pilot/Technician trainee asked how to minimize fatigue during flight operations.

Evaluation

Performance measures:	Results	
1. Discuss fatigue effects and demonstrate how to minimize fatigue.	P	F
2. Describe how to direct the sUAS Mission Pilot using the "clock position" method.	P	F

Trainee must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5013

Demonstrate DF Procedures for an ELT

CONDITIONS

You are a UAS Mission Pilot or UAS Technician trainee and must operate the UAS Beacon Locator.

OBJECTIVES

Operate the UAS Beacon Locator (UBL) in both the Search and Monitor modes, and describe how the UAS Beacon Locator should respond during a typical mission.

NOTE: These methods apply to the Marco Polo UAS Beacon Locator.

TRAINING AND EVALUATION

Training Outline

1. As a UAS Mission Pilot or UAS Technician trainee, knowing how the UAS Beacon Locator works and how to operate it is essential.

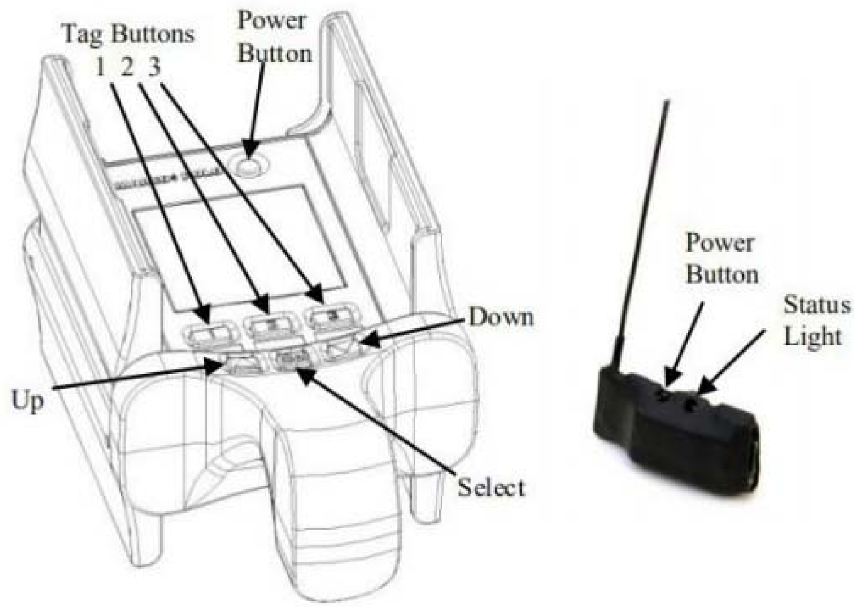
2. Marco Polo Beacon Locator. The Marco Polo Drone series Beacon Locator is a radio direction finder, the most common unit used for CAP UAS. It consists of 900 MHz UHF beacons and directional receiver unit, capable of tracking and locating up to three locator beacons.

The Beacon Locator unit is normally connected to the aircraft audio system. It has three modes: Searching, Tracking, and Monitoring.

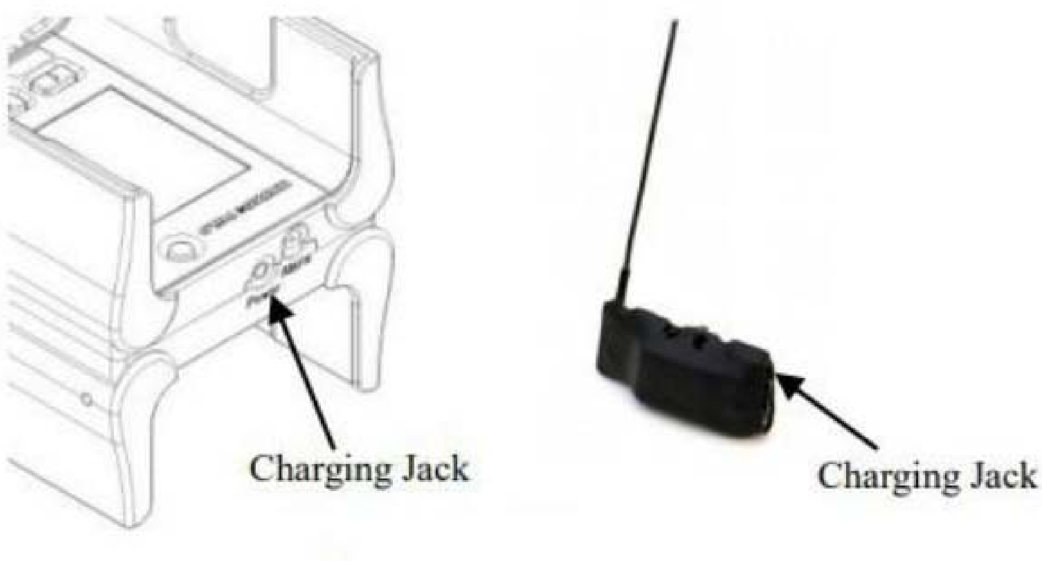
The Search and Track modes are the normal modes for routine conditions. They enable the UAS Technician to activate the Beacon unit on a mission UAS, and to identify its direction and location. The screen display provides prompts, which direct the UAS Technician to the location of the UAS.

The Monitoring mode is used for real time tracking during normal operations.

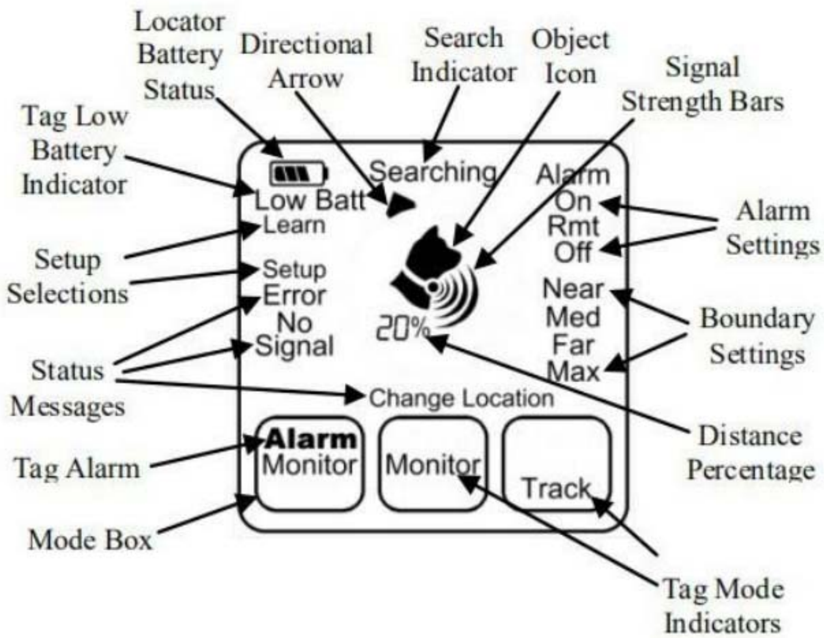
3. **Marco Polo System Components.** The system consists of two components, the radio beacon tag and the handheld locator with its display screen. Up to three aircraft tags can be synched with the locator and tracked by it.



4. Battery charging. Both the Locator and each beacon tag has a Lithium Polymer battery, which needs to be charged prior to use. The following illustration depicts the location of the micro-USB charging port on both devices. Press the power button on the beacon tag and the red LED will flash. It will remain flashing until the battery is fully charged. At that point the indicator light will go off. The display on the Locator depicts the state of battery charge when the unit is turned on. When the locator battery is fully charged the display shows a full battery.



5. **Display functions.** The primary user interface for the UAS Beacon Locator is its display. The following illustration depicts all of the functions, which can be monitored on the locator display and the tag mode indicators for each of the three tags which can be associated with the Beacon Locator.. The locator sounds various beep tones to indicate key presses, range indications, monitor alarms and error conditions.



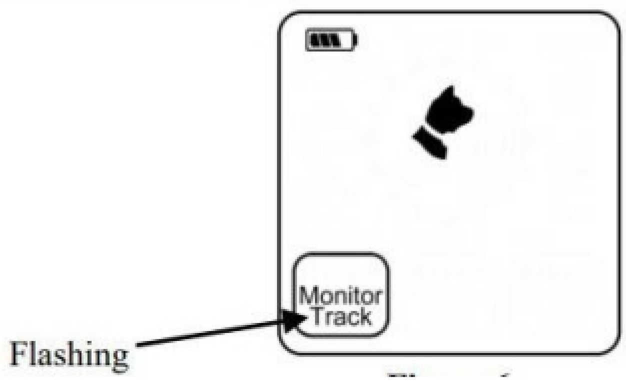
6. **Placing the beacon tag on your UAS.** To attach the tag to your UAS you may use any convenient method such as Velcro or zip ties. Take care not to apply too much pressure on the tag circuit board when using an attachment method such as zip-ties. The light weight of the tag makes excessive holding force unnecessary. It is best to place the tag in such a way that the antenna is most likely to be vertical when the tag is in operation.

7. **Powering on the Locator and Tag.** To power on the locator: Press and hold the Power button until all of the display segments flash and the locator beeps twice. To power on the beacon tag: Press and hold the Power button until the Status light flashes. The number of flashes indicates the tag's battery charge status. Three sets of three flashes means fully charged, three sets of two flashes is partially charged and one flash in each set indicates the tag requires of charging before further use. If the tag's status light shows one long flash it is turning off. If the tag is "busy" it may not respond to the off command, press the Power button again until the one long flash is shown. When the tag is on the light will flash briefly once every 10 seconds.

8. **Pairing a Beacon Tag and Locator device.** You may need to transfer the unique ID code of the beacon tag into the locator before the tag can be used. To do this, first turn the tag off but keep it nearby. Next, press and hold the Select button until Setup and Learn appear on the display. Press the down arrow button so that Learn is flashing and then press select to enter the learn mode. Now press the Tag button (1, 2 or 3) that you wish to assign to the new tag. "Searching" will now flash on the locator.

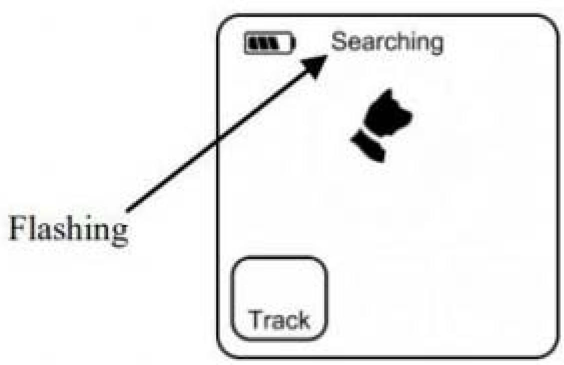
   Once the locator is in learn mode you have 20 seconds to turn the power on to the tag you wish to assign to the selected Tag button on the locator. If the tag and locator are successfully paired then the locator will beep two short beeps and the Learn display will disappear. If you wait too long to turn the tag on or if there is an error, you will hear one long beep and the locator display will say "No Signal". If this happens, turn the tag power off again and repeat the above process until the two beeps are heard.

9. **Normal Search Operations.** Once your Marco Polo beacon tag is turned on and placed on the UAS you may track its whereabouts at any time. To do this, simply turn the locator on and press the Tag button over the name or initial of the object you wish to track. When you do this the Track icon will begin to flash as shown below:



Once the Track icon is flashing you can either start the search process immediately by pressing the Select button or you can simply wait 5 seconds and the locator will enter track mode automatically. The first thing the locator does in tracking mode is send out a signal to get the tag's attention, a process called "searching". The figure below shows the appearance of the display in searching mode.

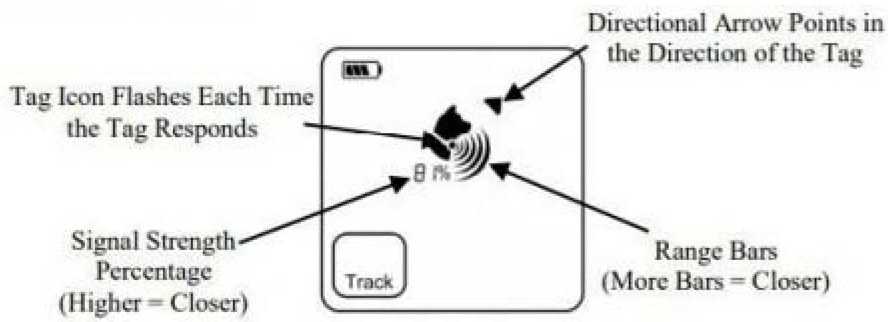
This searching transmission will continue until one of these events has occurred:



1) The tag responds
2) The operation is canceled as described below
3) Two minutes have elapsed without a response from the tag

If you wish to cancel a searching operation, then press the Tag button twice until both Track and Monitor disappear from the display.

10. **Tracking a beacon tag signal.** The pilot should climb to an altitude of at least 3000 to 4000 feet AGL, if possible, and fly to the area of the reported ELT signal (but remember, an ELT search begins the minute you take off). If the ELT cannot be heard in the expected area, climb to a higher altitude. If this fails to acquire the signal, start a methodical search (e.g., area or expanding square). Unless the beacon is known to be a 406 MHz EPIRB (which doesn't transmit on 243 MHz) or a military beacon (which uses 243 MHz and may also transmit on 121.5 MHz), switch between 121.5 and 243 MHz at least once each minute until a signal is heard. All civil beacons except 406 MHz EPIRBs and some military beacons transmit on both frequencies. Undamaged ELTs can usually be heard further on 121.5 MHz than they can on 243 MHz; the reverse is often true for damaged ELTs.



11. **Phases of a typical ELT search:** When the tracking mode is activated the locator communicates with the beacon tag about once every 4 seconds. When the beacon tag responds, the following information is updated on the display:
    a) The "tag" icon flashes to show that the tag responded to the locator.
    b) The signal strength received from the tag is measured and converted to a percentage that ranges from 0% to 99%. 99% means you are very near to the tag, 0% means you are far away.
    c) The signal strength received from the tag is also displayed as a number of "bars" (like the signal strength bars on your cell phone). The more bars that are showing the closer you are to the tag.
    d) If the locator is in an area where there are not too many obstructions, a directional arrow will display showing the direction of the tag.

In addition to the displayed information listed above, the locator will sound a number of beeps each time the tag responds. A single beep means that the tag is not in the immediate vicinity, two beeps means fairly close and three beeps indicate the tag is in close proximity.

To get the best results when tracking, always hold the locator out in front of you, waist high, level to the ground – like you are carrying a pan of water.

Additional Information

The Marco Polo User Manual and several video case studies should be reviewed prior to evaluation for this Operations Qualification.

Evaluation Preparation

Setup: Provide the student with a beacon tag and a Marco Polo UAS Beacon Locator.

Brief Student: You are a UAS Mission Pilot or UAS Technician trainee asked to set up the UAS Beacon Locator and to locate a simulated downed UAS, using a Beacon Locator and beacon tag.

Evaluation

Performance measures:	Results	
1. Describe how the UAS Beacon Locator works.	P	F
2. Pair a beacon tag with one of the UAS Beacon Locator buttons (or describe).	P	F

3. Use the UAS Beacon Locator during a typical UAS search and recovery operation. Describe how the Beacon Locator should respond during the initial acquisition phase, when you are getting close, and when you pass by the UAS. P F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5014
<u>Complete a Mission Sortie</u>

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must demonstrate how to complete a mission sortie.

OBJECTIVES

Complete a mission sortie, acting as UAS Mission Pilot in Command. Perform or describe mission duties during a sortie, actions upon return to mission base, perform an aircrew debriefing, complete the Debriefing section of the sortie in WMIRS or on paper, and get a sortie debriefing from mission staff.

TRAINING AND EVALUATION

Training Outline

1. As a UAS Mission Pilot/Technician trainee, the ability to complete the operational phases of a mission sortie is essential. The MP must take current flight conditions into consideration (e.g., gross weight, turbulence, and terrain) and perhaps add a margin of safety to the assigned search altitude and airspeed. Log these deviations from the assigned search parameters; when you get back from your sortie you can debrief what you did and why.

2. Plan a flight that includes one or more search patterns. The trainer will act as a Mission Technician on the sortie. Enter the sortie Planning and Briefing information in WMIRS and get a CAP flight release.

3. Preflight the aircraft, brief the Technician, and begin the flight.

4. During your sortie, complete the following:

    a. Transit to the Search Area
        1) Relax sterile cockpit rules
        2) Maintain situational awareness
        3) Double-check navigational settings to be used in the search area
        4) Review search area terrain and obstacles
        5) Update in-flight weather
        6) Review methods to reduce fatigue during the search

    b. Approaching the Search Area
        1) Exterior lights on (maximize your visibility so others can "see and avoid")
        2) Review search objectives and check special equipment
        3) Double-check radio, telemetry and control station settings
        4) Stabilize at search heading, altitude, and speed. Implement sterile cockpit rules
        5) Evaluate the scene (situational awareness) for conflicting traffic

    c. In the Search Area
        1) Log time and report by radio "In the Search Area"
        2) Enter deviations from assigned search parameters in UAS Technician's Log
        3) 5-minute updates – Altitude and battery capacity
        4) Report "Operations Normal" at assigned intervals

5) Maintain at least 200' AGL during daylight
6) Maintain at least 300' AGL during nighttime
7) Monitor for crew fatigue
8) If you sight the objective, notify mission base at once
9) Log all "negative result" sightings and review all photos (reshoot if necessary)

d. Departing the Search Area
1) Log time and report "Out of the Search Area"
2) Double-check heading and altitude assigned for transit to next search area or return to base
3) Organize the crew and cockpit for approach and landing

e. Approach, Descent and Landing
1) Plan approach and descent
2) Double-check radio settings
3) Brief crew assignments for approach and landing
4) Remind crew that most midair collisions occur in or near the traffic pattern, especially on final
5) Begin sterile cockpit and assign crew duties for critical phases of flight
6) Double-check assigned approach heading and altitude
7) During descent to check for traffic
8) Log (time and Hobbs) and report "Landing"

f. Secure Aircraft
1) Double-check UAS battery is OFF
2) Battery removed; check battery for excessive heat
3) Check motors for excessive heat and possible FOD
4) Gimbal lock in place – Sensor covers on – sensors cleaned
5) Complete the Flight Log and enter any new items in Discrepancy Log (paper)
6) Remove rotor blades and blade guards and conduct post-flight checklist
7) Put UAS in storage case
8) Conduct a visual check of the landing area for any stray pieces of equipment

5. Aircrew debriefing. During the briefing everything that is known about the mission was passed along to the air and ground teams. In the debriefing, the reverse is true.

a. Take a short break then assemble the crew to complete the Debriefing section in WMIRS
1) Fill in or verify 'ATD' and 'Actual Landing Time'
2) The Summary section describes what you accomplished on the sortie
3) The Results/Deliverables section can be as simple as "no sightings" or "no damage noted." However, you must list results such as sightings (including negative sightings), the number of photos you took, etc.
4) The Weather Conditions section can be as simple as entering "as forecast." However, if the weather was unexpected it is important to explain how the weather conditions affected sortie effectiveness.
5) The Remarks section is for entering any information you think is pertinent or helpful that was not entered elsewhere in WMIRS. It also gives the crew a chance to comment on the effectiveness of the sortie in detail.
6) The Sortie Effectiveness section involves a quantitative assessment of how well you accomplished your mission.
7) The Attachments & Documentation section is self-explanatory. Ensure all entries and sketches/drawings are clear and legible and upload into WMIRS. Be sure to label each attachment (e.g., mission and sortie number) so they can be related to the mission/sortie if it accidentally becomes separated.

8) Turn in/upload photos and/or video.
9) Begin recharging batteries.

b. Check in with Debriefing Officer
1) Tell how you did your job and what you saw.
2) Usually starts with a review of the information you entered into WMIRS.
3) Answer all questions as best you can, and be very honest about conditions and your actions.
4) If you are scheduled for another sortie, find someplace to rest. Close your eyes; you may even want to take a nap if there is time and a place to do so. Also, take in some refreshment to give you sufficient energy for the next sortie.
5) Ensure that the air crew obtains sufficient rest during crew rest periods, including approval of extensions to the maximum air crew duty period (CAPR 70-1U)

Notes on Debriefing
Each search team (air and ground) tells how it did its job and what it saw. This type of information is given in detail and is in the form of answers to specific questions asked by the debriefer. The information is then passed on the planning section for analysis, and the information may then be passed on, in turn, to departing search crews. [Note: An aircrew or ground team cannot search and have "negative results". Even if the objective is not located, important information can be obtained, such as weather, turbulence, ground cover, and false clues.]

The debriefer uses the information you entered in WMIRS as a starting point for the debriefing. For example, more information on search area and weather conditions may be needed, and you should be ready to volunteer your observations. Perhaps you noticed an increase in cloud shadows. Perhaps visibility seemed to deteriorate because of the haze that developed after you arrived in the search area. Perhaps turbulence developed during the last one-third of your grid search. Any number of weather or personal factors could have changed during your sortie. To make the best contribution to the debriefing requires that you remember these changes and be prepared to tell the debriefer about them:

Did you make any changes to the planned search procedure? The debriefer’s primary concern is to determine adequate search coverage. If, for example, you diverted frequently to examine clues, there is a good possibility that search coverage was not adequate and that another sortie is justified. If you become excessively tired and rested your eyes frequently, tell the debriefer. Everyone understands the degree of fatigue a scanner can experience. But, frequent rest-eye periods will reduce the level of good scanning coverage, and also could be justification for another sortie.

What types of clues did you investigate? Perhaps a clue seemed to be insignificant and you decided not to pursue it. Describe any clues that were investigated and found to be false. This information becomes part of the briefing for other aircrews because it can keep them from pursuing the same false clues.

Debriefing results are provided to the operations staff and incident commander, periodically or whenever significant items are evident. At the end of each operational period, the incident commander and staff will review the debriefing forms to develop the complete search picture, compute probabilities of detection and cumulative POD, and then determine priorities and make plans for the next operational period.

When the debriefer is satisfied that pertinent information has been discussed and explained, you will be dismissed. Now what should you do? Obviously, you will need rest. If you are scheduled for another sortie, find someplace to rest. Close your eyes; you may even want to take a nap if there is time and a place to do so. Also, take in some refreshment to give you sufficient energy for the next sortie.

Additional Information

The UAS Pilot Checklists for your aircraft are important references for your preparation for this qualification flight.

Practice

Setup: The student will complete a mission sortie, acting as both aircraft and mission commander. The student should have access to typical mission base materials, WMIRS or paper logs, and an aircraft.

The student will discuss (or perform) required actions during the sortie, secure the aircraft upon return, perform an aircrew debriefing, and fill out the Debriefing section in WMIRS or on paper. All tasks that can be performed will not be simulated.

The trainer should play the role of Mission Technician during the sortie, receiving instructions from the student and providing feedback as necessary to complete task objectives.

During post-flight and pilot debriefing, ensure that the student completes aircraft and mission paperwork. The trainer will then play the role of Debriefing Officer and debrief the student, checking WMIRS and paper logs for accuracy and completeness.

For this sortie, watch for:
1) Knowledge of mission sortie requirements
2) Proper and complete aircrew briefing
3) Actions upon return to base
4) Thorough knowledge of the information required by WMIRS and paper logs
5) Accurate completion of WMIRS and paper log entries and uploads
6) Knowledge of debriefing objectives and procedures

Evaluation Preparation

Setup: The student will complete a mission sortie. The student should have access to typical mission base materials and an aircraft.

The student will plan a sortie that includes one or more mission search patterns, discuss (or perform) required actions during the sortie, secure the aircraft upon return, perform an aircrew debriefing, and fill out the Debriefing section in WMIRS or on paper logs, including uploads. All tasks that can be performed will not be simulated.

The trainer will play the role of a sUAS Technician during the sortie, receiving instructions from the student and providing feedback as necessary to complete task objectives.

During sortie debriefing, ensure that the student completes all mission paperwork. Play the role of Debriefing Officer and debrief the student, checking WMIRS entries for accuracy and completeness.

Brief Student: You are a sUAS Mission Pilot trainee asked to complete a sortie

Evaluation

Performance measures:	Results	
1. Describe or perform required actions during a sortie: a. Actions to be taken if the search objective is found. b. Actions to be taken if you deviate from assigned search parameters.	P	F
2. Complete the Debriefing section in WMIRS, including uploads.	P	F

3. Return memory card with imagery products, flight logs, etc. P F

4. Perform a debriefing with a Debriefing Officer. P F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5015

Demonstrate Planning and Flying a Route Search

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must demonstrate how to plan and fly a route search.

OBJECTIVES

Demonstrate how to plan and fly a route search.

TRAINING AND EVALUATION

Training Outline

1. As a Mission Pilot trainee, the ability to plan and perform a route search pattern is essential.

2. **General**. Because of the accuracy and reliability of the present Global Positioning System and GPS receivers, CAP aircrews are now able to navigate and fly search patterns with unprecedented effectiveness and ease. The challenge for SAR with UAS is coordinating the flying with maximizing opportunity for the UAS Technician (scanner) to access high resolution video of the search.

   The UAS Mission Pilot (or the UAS Technician) must decide how scanners will access the video data stream. One or more scanners can be provided with live real time feeds, or one or more scanners can have later post flight access to video and telemetry. Planning and executing a search pattern with only the UAS Mission Pilot or a UAS Tech scanner watching video is quite different from when you have scanners review of live video, or deferred post-flight video.

   When you are planning and flying search patterns, always perform a stupid check -- as in "Hey! Wait a minute. This is stupid." Use this to see if your headings, waypoint positions, lat/long coordinates and distances look sensible. At a minimum, perform this check after you finish planning, when you start your pattern, and periodically thereafter. For example, you've just turned to the heading shown on your plan. You know the coordinates represent a lake southwest of your position, so check the heading indicator to see you're actually traveling in a southwesterly direction. Or, you know the lake is approximately 25 miles away; check the actual distance! You'd be surprised how many mistakes this method will catch.

   Pre-planning (plotting) your search pattern results in the most effective search. Pre-planning sets the details of the flight in your mind and makes flying it much easier. Worksheets can be used (see the Flight Guide, Attachment 2) to pre-plan your search patterns, but they are just one method. In practice, a UAS Technician can read the headings and maneuvers to the Mission Pilot while the UAS is over the search area.

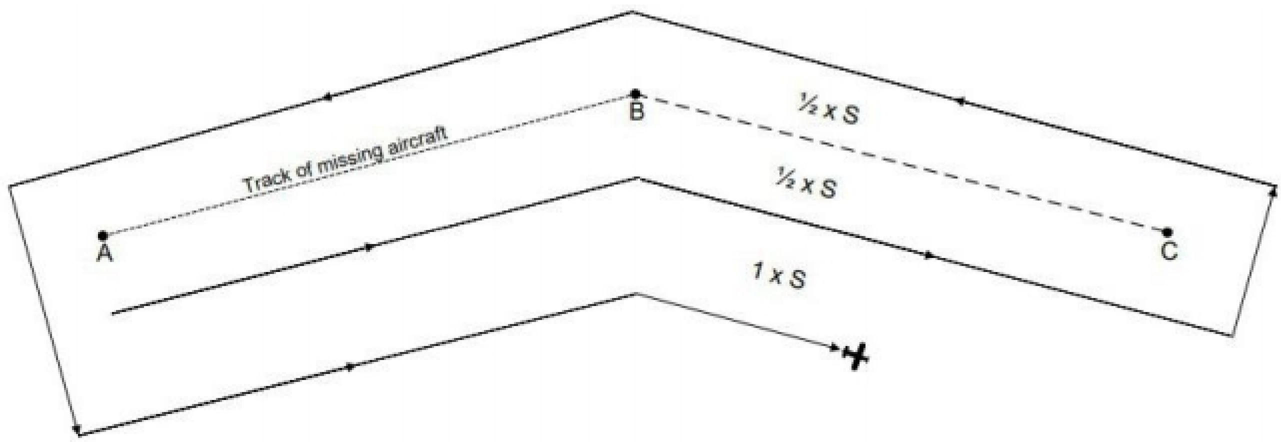
   Another recommended way to pre-plan and fly your search pattern is to use Mission Planner to design the pattern, specify track spacing, maintain overlap, estimate flight time, and then you can fly it manually, if autonomous flight modes are not available.

   If autonomous modes of flight are available, your pre-planned search pattern can be designed in Mission Planner, uploaded to the UAS, and flown autonomously.

3. **Route search pattern**. The route (track line) search pattern is normally used when an aircraft vehicle, or person, is missing. This search pattern is based on the assumption that the missing aircraft has crashed or made

a forced landing on or near its intended track (route). It is assumed that detection may be aided by survivor signals or by electronic means. The track line pattern is also used for night searches (in suitable weather). A search UAS using the track line pattern flies a rapid and reasonably thorough coverage on either side of the missing aircraft's intended track from the last known position (LKP) to the destination.

4. Search altitude for the route search pattern usually ranges from 200-400 feet above ground level (AGL) for day searches, while night searches range 300 to 400 feet AGL (either depending upon light conditions and



visibility). Lat/long coordinates for turns are determined and then entered into Mission Planner (MP) as waypoints, which may then be compiled into a flight plan.

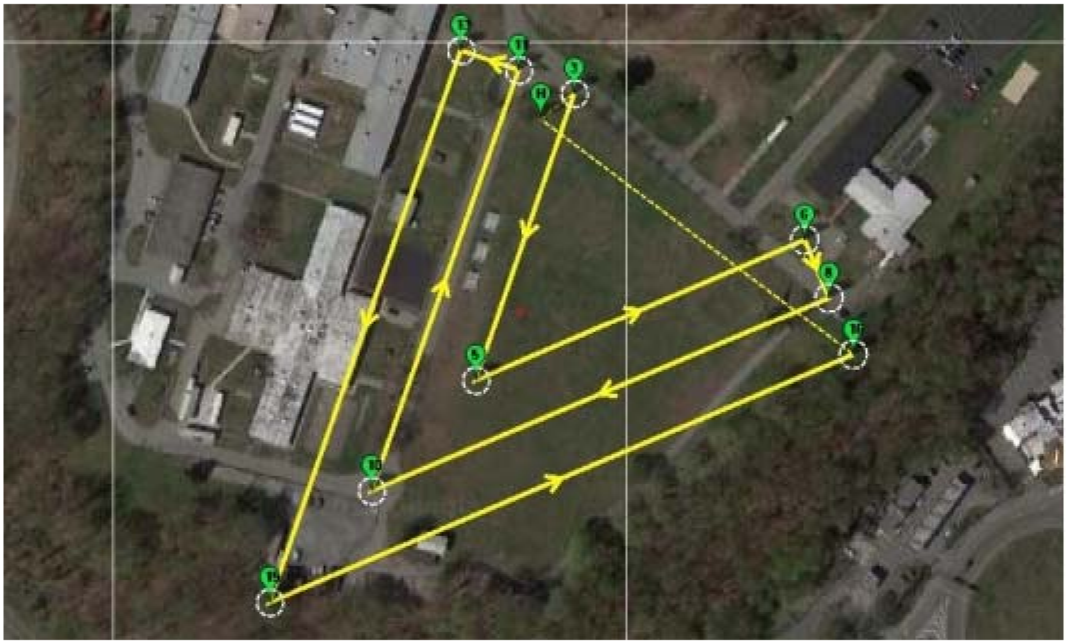
The search crew begins by flying parallel to the missing aircraft's intended course line, using the track spacing (labeled "S") determined by the incident commander or planning section chief. On the first pass, recommended spacing may be one-half that to be flown on successive passes. Flying one-half "S" track spacing in the area where the search objective is most likely to be found can increase search coverage.

5. You may use a worksheet to draw the route and to log coordinates and distinctive features. As a backup, note applicable VOR radials and cross-radials. You may also put the route waypoints into MP and then construct a route search around them.

6. Track spacing. The most important design factor when you plan your search pattern is the determination of the distance between tracks. The following factors go into a calculation of the track spacing:

- Altitude flown
- Camera lens focal length
- Camera sensor size and image dimensions.
- Speed
- Overlap in direction of flight
- Overlap in lateral directions

The easiest way to calculate track width is to let Mission Planner do it for you.



Additional Information

Search patterns are covered in MP Tasks O-2102 thru O-2105 and may be combined in any fashion. More detailed information and figures on this topic are available in Chapter 8 of the MART Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text.

Practice

Setup: Give the trainee a route search to plan and fly. Depending on which UAS will be flown, choose the appropriate ground control software or app.

The route may be along a highway (to avoid straight lines) and should be of sufficient length (out and back) to allow the student time to demonstrate proficiency in all aspects of the search. Search altitude, airspeed and track spacing should be selected to match terrain and conditions: 200’ to 250’ AGL, 10 knots, and 30 yards track spacing is recommended.

Depending on the level of proficiency of the pilot, one or more of these tasks may be practiced simultaneously.

Planning. All mission sorties must be thoroughly planned: this ensures the pilot and crew can accomplish the sortie objectives safely and precisely. Treat each sortie as if it were an actual mission. Each time the student practices a sortie all required paperwork and WMIRS entries should be completed as part of the drill. The student should sign herself and the aircraft into the mission, receive her assignment from you (the Briefing Officer), plan the sortie, and complete the Planning and Briefing sections in WMIRS. Review the ORM, W&B, fuel assumptions, and information entered into WMIRS thoroughly.

Preflight and pilot briefings. Ensure the student performs a thorough preflight of the aircraft. Acting as a crewmember, receive pilot safety and mission briefings from the student. Perform safety assignments as directed by the student.

Equipment. To the extent possible, the student should operate the control station. The student should set up and enter information into the equipment prior to takeoff.

Initial training. Depending on the proficiency and skills of the student, the training pilot may need to demonstrate all aspects of a route search with the student watching. This gives the student time to absorb the information and work on such skills as setting up, entering data, and using the navigational equipment without the added responsibilities of the PIC.

For each practice sortie, watch for:

1) Proper configuration of the UAS and ground control app.

2) Stabilized entry into the search area. The aircraft should be at search altitude and airspeed at least ten seconds before entering the search area.

3) Accurate and precise navigation. The student should maintain altitude, airspeed and track in the search area. Watch for proper wind drift correction and airspeed adjustments. Ensure the turns are started soon enough to stay inside the search area without requiring abrupt turns.

4) Safety. The student should spend most of her time looking at the aircraft (see and avoid). Initially, the student will spend too much time with her eyes on the control station. Get the student into the habit of not looking away from the aircraft for more than five seconds at a time to manipulate communications and navigational equipment.

Evaluation Preparation

Setup: Give the student a route search to plan and fly. The student should have Mission Planner, a sectional chart, plotter, and worksheets as needed.

The route may be along a highway (to avoid straight lines) and should be of sufficient length (out and back) to allow the student time to demonstrate proficiency in all aspects of the search. Search altitude, airspeed and track spacing should be selected to match terrain and conditions: 200' to 300' AGL, 10 knots, and 30 yards track spacing is recommended.

Run the sortie as it would be during an actual mission. Have the student sign in, sign in the aircraft, and complete all required paperwork. Brief and debrief the sortie as if you were the Briefing/Debriefing Officer during a mission.

During the flight the camera gimbal will be set to nadir position (perpendicular to the ground). The camera will be set to take pictures at 3 second intervals. At the conclusion of the flight, the memory card will be turned in to download images for the flight. Student will use images to demonstrate knowledge of image processing for orthomosaic images.

Brief Student: You are a Mission Pilot trainee asked to plan and fly a route search to collect aerial imagery.

Evaluation

Performance measures:	Results	
1. Sign yourself and your aircraft into the mission.	P	F

2. Receive a sortie briefing, asking questions as necessary.	P	F
3. Plan a route search from Point A to B and back. Include: a. Estimated time enroute and battery requirements. b. Position coordinates for the route. c. Altitude restrictions, obstacles and other hazards (e.g., MTRs and SUAs). d. Discuss observer/scanner assignments for all possible combinations.	P	F
4. Fill out the Flight Plan and Briefing sections in WMIRS or on paper forms.	P	F
5. Preflight the aircraft and perform pilot safety and mission briefings.	P	F
6. Demonstrate and discuss safety during each critical phase of the flight. In particular, demonstrate collision avoidance and enforce sterile cockpit rules.	P	F
7. Demonstrate proper communications and call sign usage.	P	F
8. Setup the CAP FM radio and perform all required radio reports (may be simulated).	P	F
9. Perform the route search. Demonstrate: a. Proper use of navaids and telemetry. b. Proper use of radio for communication . c. Entry at the proper point, stabilized at search altitude and speed. d. Accurate altitude and speed control in the search area. e. Turns accomplished accurately and smoothly. f. Accurate navigation and track spacing. g. Proper observer/scanner direction (may be simulated).	P	F
10. Demonstrate proper attention to battery management.	P	F
11. Properly secure the aircraft at the end of the flight (ready for next sortie).	P	F
12. Fill out the Debriefing section in WMIRS or on paper and debrief the sortie.	P	F
13. Successfully collected imagery from flight - Removed Memory card.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5016

<u>Demonstrate Planning and Flying a Parallel Track Search</u>

CONDITIONS

You are a UAS Mission Pilot or UAS Technician trainee and must demonstrate how to plan and fly a parallel track search, sometimes called a survey or grid pattern.

OBJECTIVES

Demonstrate how to plan and fly a parallel track search.

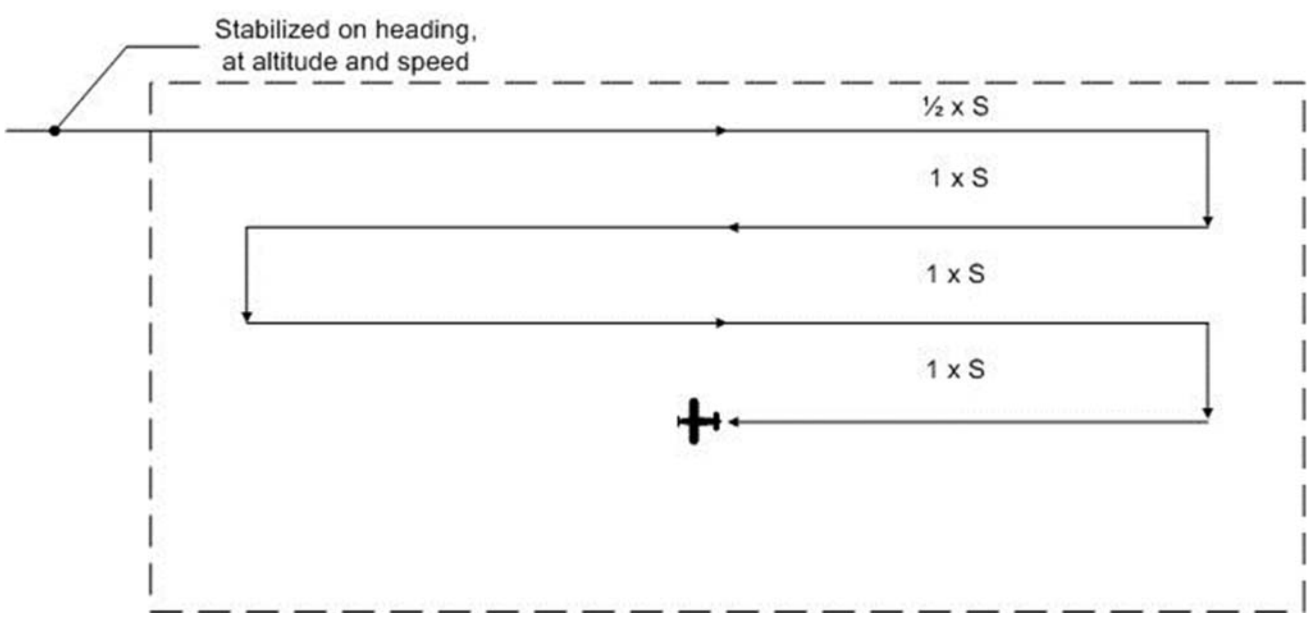
TRAINING AND EVALUATION

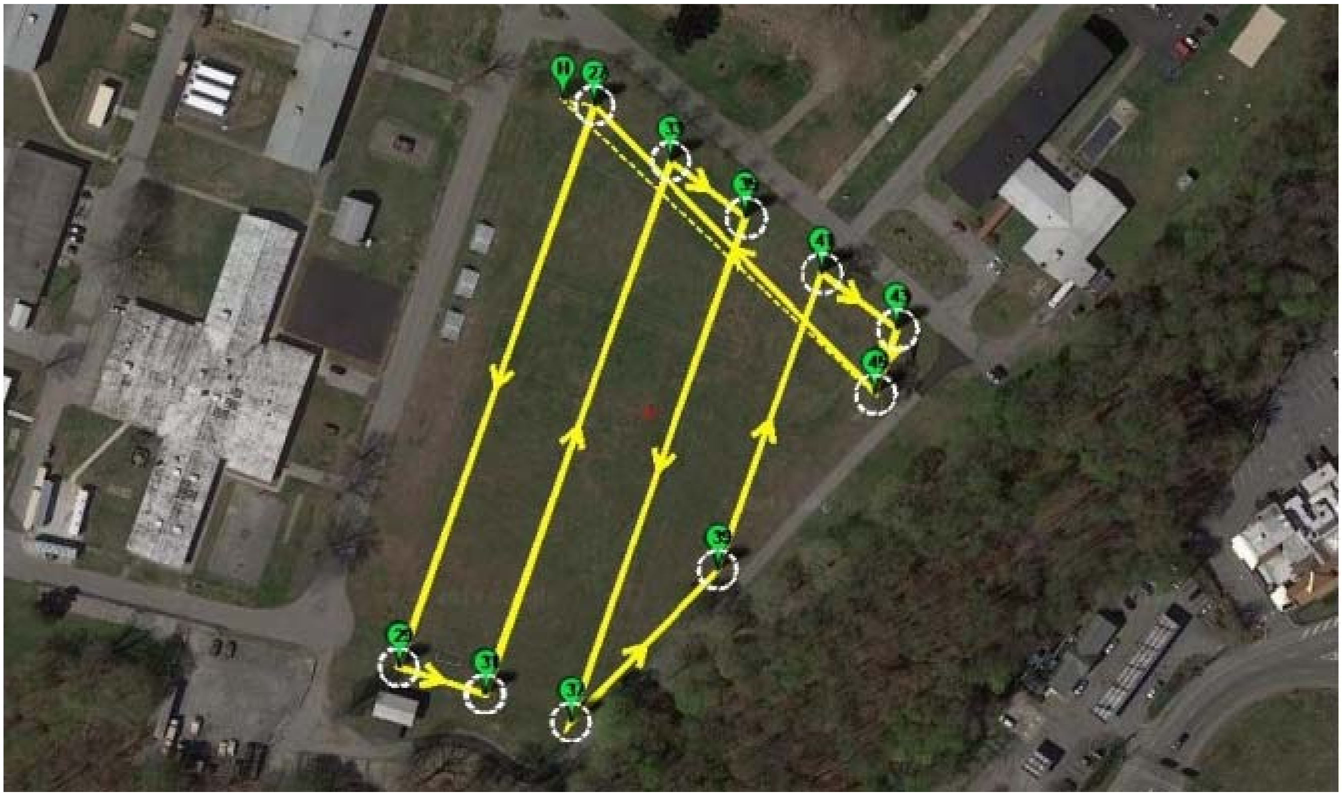
Training Outline

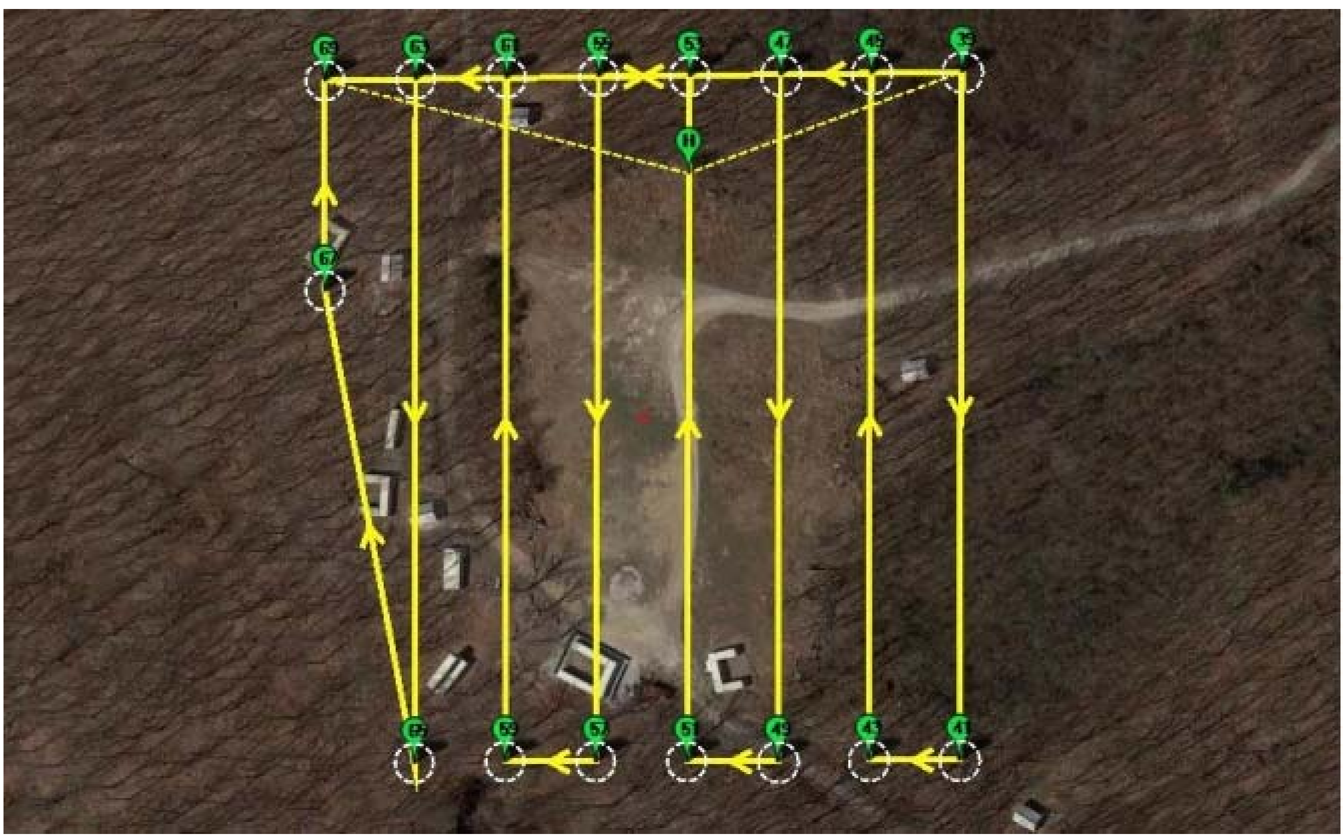
1. As a UAS Mission Pilot/Technician trainee, the ability to plan and fly a parallel track search pattern is essential.

2. Parallel Track search pattern. The parallel track (sweep) search pattern is normally used when one or more of the following conditions exist: a) the search area is large and fairly level, b) only the approximate location of the target is known, or c) uniform coverage is desired. This pattern of search is used to search a grid, or to obtain imagery for mapping.

3. The aircraft proceeds to a corner of the search area and flies at the assigned altitude, sweeping the area maintaining parallel tracks. The first track is at a distance equal to one-half (1/2) track spacing (S) from the side of the area.







4. The ground control software apps from DJI (Ground Station Pro), and Mission Planner should be used to plan and fly the mission.

5. Track spacing. The most important design factor when you plan your search pattern is the determination of the distance between tracks. The following factors go into a calculation of the track spacing:

   - Altitude flown
   - Camera lens focal length
   - Camera sensor size and image dimensions
   - Overlap in direction of flight
   - Overlap in lateral directions (sidelap)

The easiest way to calculate track width is to let Mission Planner do it for you. Use Mission Planner to design the pattern, specify track spacing, maintain overlap, estimate flight time, and then you can fly it manually, if autonomous flight modes are not available.

If autonomous modes of flight are available, your pre-planned search pattern can be designed in Mission Planner, uploaded to the UAS, and flown autonomously

Additional Information

Search patterns are covered in MP Tasks O-2102 thru O-2105 and may be combined in any fashion. More detailed information and figures on this topic are available in Chapter 8 of the MART Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text.

Practice

Setup: Give the student a polygon area to search. Have them plan the best search pattern. The student should have a sectional chart, plotter, and worksheets as needed, or access to Mission Planner.

This search method is most often used inside a grid, and the student has to master several tasks in order to be proficient in flying a parallel track inside a grid.

Depending on the level of proficiency of the pilot, one or more of these tasks may be practiced simultaneously.

Planning. All mission sorties must be thoroughly planned: this ensures the pilot and crew can accomplish the sortie objectives safely and precisely. Treat each sortie as if it were an actual mission. Each time the student practices a sortie all required paperwork and WMIRS entries should be completed as part of the drill. The student should sign herself and the aircraft into the mission, receive her assignment from you (the Briefing Officer), plan the sortie, and complete the Planning and Briefing sections in WMIRS. Review the ORM, W&B, battery requirements, and information entered into WMIRS thoroughly.

Preflight and pilot briefings. Ensure the student performs a thorough preflight of the aircraft. Acting as a crewmember, receive pilot safety and mission briefings from the student. Perform safety assignments as directed by the student.

Equipment. To the extent possible, the student should operate the controller and flight plan set up.

Initial training. Depending on the proficiency and skills of the student, the training pilot may need to demonstrate all aspects of a route search with the student observing. This gives the student time to absorb the information and work on such skills as setting up, entering data, and using the tablet app or laptop program without the added responsibilities of the PIC.

For each practice sortie, watch for:

1) Proper configuration of the UAS.
2) Stabilized entry into the search area. The aircraft should be at search altitude and airspeed at least 30 seconds before entering the search area.
3) Accurate and precise navigation. The student should maintain altitude, airspeed and track in the search area. Watch for proper wind drift correction and airspeed adjustments. Ensure the turns are started soon enough to stay inside the search area without requiring abrupt turns.
4) Safety. The student should spend most of her time looking at the aircraft (see and avoid). Initially, the student will spend too much time with her eyes on the control station. Get the student into the habit of not looking away from the aircraft for more than five seconds at a time to manipulate communications and navigational equipment.

Evaluation Preparation

Setup: Give the student a parallel track search to plan and fly. The student should have a sectional chart, plotter, and worksheets as needed, or access to Mission Planner software.

The student will enter and fly the grid using the parallel track search method long enough to demonstrate proficiency in all aspects of the search. Search altitude, airspeed and track spacing should be selected to match terrain, altitude, and conditions: 200’ AGL, 10 knots, and 30 yards track spacing is recommended.

Run the sortie as it would be during an actual mission. Have the student sign in, sign in the aircraft, and complete all required paperwork. Brief and debrief the sortie as if you were the Briefing/Debriefing Officer during a mission.

During the flight the camera gimbal will be set to nadir position (perpendicular to the ground). The camera will be set to take pictures at 3 second intervals. At the conclusion of the flight, the memory card will be turned in to download images for the flight. Student will use images to demonstrate knowledge of image processing for orthomosaic images.

Brief Student: You are a UAS Mission Pilot trainee asked to plan and fly a parallel track search of a grid.

Evaluation

Performance measures:	Results	
1. Sign yourself and your aircraft into the mission.	P	F
2. Receive a sortie briefing, asking questions as necessary.	P	F
3. Plan a parallel track search of a grid. Include:	P	F

a. Estimated time enroute, time in the AOI, and battery requirements.
b. Position coordinates for the entry and exit points.
c. Position coordinates for the grid legs.
d. Altitude restrictions, obstacles and other hazards.

e. Discuss crew member assignments for all possible combinations.

4.	Fill out the Flight Plan and Briefing sections in WMIRS or on paper.	P	F
5.	Preflight the aircraft and perform pilot safety and mission briefings.	P	F
6.	Demonstrate and discuss safety during each critical phase of the flight. In particular, demonstrate collision avoidance and enforce sterile cockpit rules.	P	F
7.	Setup the CAP FM radio and perform all required radio reports (may be simulated).	P	F
8.	Fly the grid search. Demonstrate: a. Proper use of navaids. b. Proper use of radios (ATC as required, and CAP FM radio reports). c. Entry at the proper point, stabilized at search altitude and speed. d. Accurate altitude and speed control inside the grid. e. Turns accomplished accurately and stays inside the gird. f. Accurate navigation and track spacing. g. Proper observer/scanner direction (may be simulated).	P	F
9.	Demonstrate proper attention to battery management.	P	F
10.	Properly secure the aircraft at the end of the flight (ready for next flight).	P	F
11.	Fill out the Debriefing section in WMIRS or on paper, and debrief the sortie.	P	F
12.	Successfully collect imagery from flight - Remove Memory card	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5017

Demonstrate Planning and Flying a Creeping Line Search

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must demonstrate how to plan and fly a creeping line search.

OBJECTIVES

Demonstrate how to plan and fly a creeping line search.

TRAINING AND EVALUATION

Training Outline

1. As a UAS Mission Pilot/Technician trainee, the ability to plan and fly a creeping line search pattern is essential.

2. Creeping Line search pattern. The creeping line search pattern is similar to the parallel patterns. The parallel pattern search legs are aligned with the major, or longer, axis of the rectangular search areas, whereas the search legs of the creeping line pattern are aligned with the minor or shorter axis of rectangular search areas. The creeping line pattern is used when:

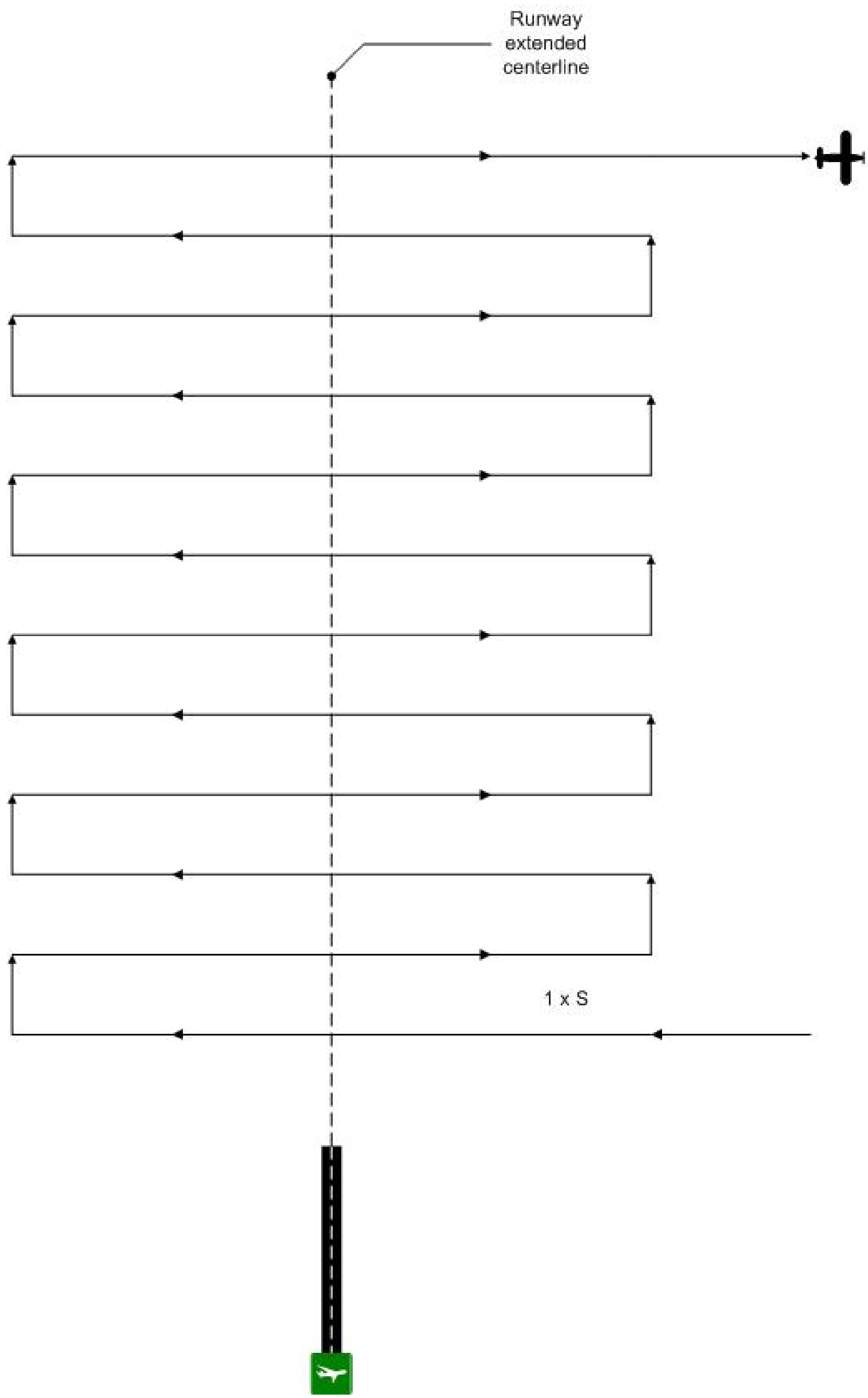
   a) the search area is narrow, long, and fairly level,

   b) the probable location of the target is thought to be on either side of the search track within two points, or

   c) there is a need for immediate coverage of one end of the search area.

   d) the search is focused on a linear feature like a highway, railroad tracks, river, ridge, palisade, coastline, or canal and the end points on that feature are bounded.

3. The creeping line is a succession of search legs along a line. The starting point is located one-half search track spacing inside the corner of the search area.



Note: By using this technique you will actually be flying arcs instead of the usual squared (rectangular) legs. This is of little concern since the purpose is to cover the entire search area in a methodical manner.

This method is very handy when you are assigned a creeping line while airborne. It's easy to plan, set up and perform once you have mastered the technique.

This method can also be used along a winding river or a road, but the pilot must plan a line that roughly bisects the winding route and then vary the length of the legs as conditions warrant on the ground below.

4. **Track spacing.** The most important design factor when you plan your search pattern is the determination of the distance between tracks. The following factors go into a calculation of the track spacing:

- Altitude flown
- Camera lens focal length
- Camera sensor size and image dimensions
- Speed
- Overlap in direction of flight
- Overlap in lateral directions (sidelap)

The easiest way to calculate track width is to let Mission Planner do it for you. Use Mission Planner to design the pattern, specify track spacing, maintain overlap, estimate flight time, and then you ca fly it manually, if autonomous flight modes are not available.

If autonomous modes of flight are available, your pre-planned search pattern can be designed in Mission Planner, uploaded to the UAS, and flown autonomously.

Evaluation Preparation

Setup: Give the student a creeping line search to plan and fly. The student should have a sectional chart, plotter, and worksheets as needed, or access to Mission Planner software.

Two kinds of creeping line searches should be practiced: one along a highway and the other along the imaginary extended centerline of an airport runway. The highway will demonstrate how to do a creeping line along a route with curves, where the student will have to make constant adjustments in order to ensure proper leg length. The extended runway centerline will demonstrate how to do a creeping line without regular ground references.

The student will enter and fly the grid using the creeping line search method long enough to demonstrate proficiency in all aspects of the search. Search altitude, airspeed and track spacing should be selected to match terrain, altitude, and conditions: 200' AGL, 10 knots, and 30 yards track spacing is recommended.

Run the sortie as it would be during an actual mission. Have the student sign in, sign in the aircraft, and complete all required paperwork. Brief and debrief the sortie as if you were the Briefing/Debriefing Officer during a mission.

During the flight the camera gimbal will be set to nadir position (perpendicular to the ground). The camera will be set to take pictures at 3 second intervals. At the conclusion of the flight, the memory card will be turned in to download images for the flight. Student will use images to demonstrate knowledge of image processing for orthomosaic images.

Brief Student: You are a UAS Mission Pilot trainee asked to plan and fly a creeping line search of a route.

Evaluation

Performance measures:	Results	
1. Sign yourself and your aircraft into the mission.	P	F
2. Receive a sortie briefing, asking questions as necessary.	P	F
3. Plan a creeping line search of a grid. Include: f. Estimated time enroute, time in the AOI, and battery requirements. g. Position coordinates for the entry and exit points. h. Position coordinates for the grid legs. i. Altitude restrictions, obstacles and other hazards. j. Discuss crew member assignments for all possible combinations.	P	F
4. Fill out the Flight Plan and Briefing sections in WMIRS or on paper.	P	F
5. Preflight the aircraft and perform pilot safety and mission briefings.	P	F
6. Demonstrate and discuss safety during each critical phase of the flight. In particular, demonstrate collision avoidance and enforce sterile cockpit rules.	P	F
7. Setup the CAP FM radio and perform all required radio reports (may be simulated).	P	F
8. Fly the creeping line search. Demonstrate: h. Proper use of navaids. i. Proper use of radios. j. Entry at the proper point, stabilized at search altitude and speed. k. Accurate altitude and speed control inside the grid. l. Turns accomplished accurately and stays inside the gird. m. Accurate navigation and track spacing.	P	F

n. Proper observer/scanner direction (may be simulated).

9. Demonstrate proper attention to battery management. P F

10. Properly secure the aircraft at the end of the flight (ready for next flight). P F

11. Fill out the Debriefing section in WMIRS or on paper, and debrief the sortie. P F

12. Successfully collect imagery from flight - Remove Memory card P F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5018

Demonstrate Planning and Flying a Point Based Search

CONDITIONS

You are a UAS Mission Pilot/Technician trainee and must demonstrate how to plan and fly point-based searches.

OBJECTIVES

Demonstrate how to plan and fly a point-based search (expanding square or sector).

TRAINING AND EVALUATION

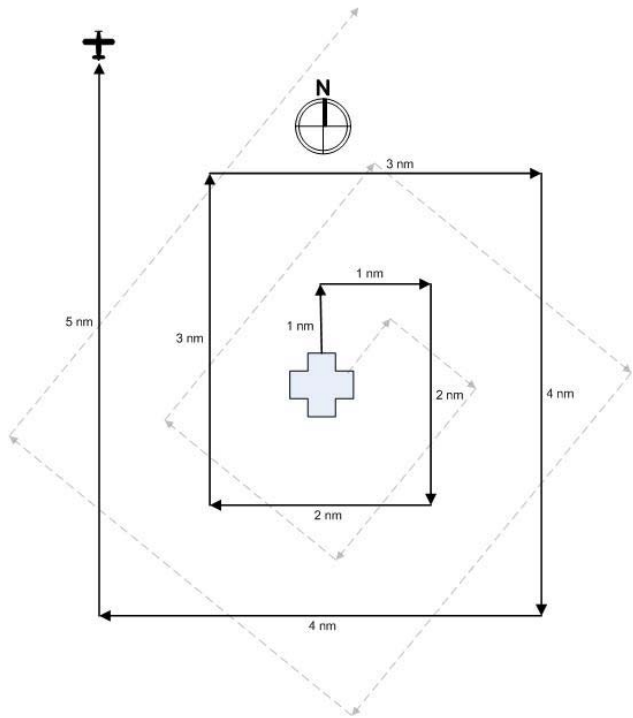
Training Outline

1. As a Mission Pilot trainee, the ability to plan and fly a point-based search pattern is essential.

   Point-based searches are organized around a point on the ground. These patterns are used when the approximate location of the target is known and are not intended to cover large areas. Examples are the expanding square, sector and circle search patterns.

2. Expanding Square search pattern. The expanding square search pattern is normally used when the search area is small (normally, areas less than 10 acres square), and the position of the survivors is known within close limits. This pattern begins at an initially reported position and expands outward in concentric squares. If error is expected in locating the reported position, or if the target were moving, the square pattern may be modified to an expanding rectangle with the longer legs running in the direction of the target's reported, or probable, movement.

   If the results of the first square search of an area are negative, the search unit can use the same pattern to cover the area more thoroughly. The second search of the area should begin at the same point as the first search; however, the first leg of the second search is flown diagonally to the first leg of the first search. Consequently, the entire second search diagonally overlays the first one. The bold, unbroken line in the figure illustrates the first search, while the dashed line represents the second search. Track spacing indicated is "cumulative," showing the total width of the search pattern at a given point on that leg. Actual distance on a given leg from the preceding leg on the same side of the pattern is still only one "S," the value determined by the incident commander or planning section chief.

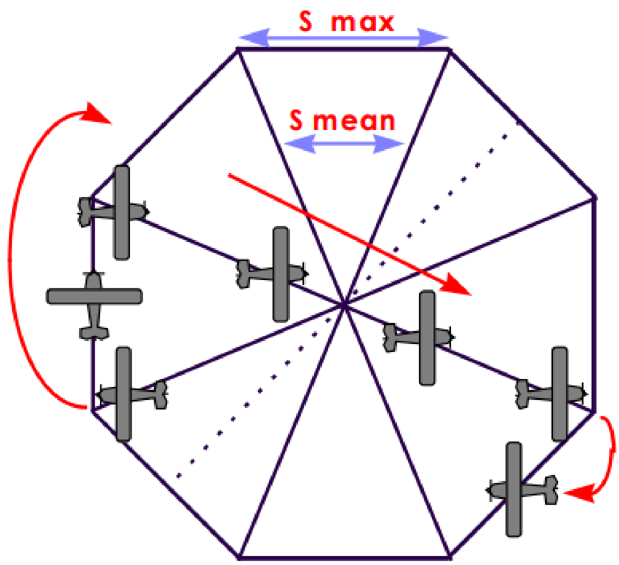


3. The GPS capability of the UAS is used because this pattern requires precise navigation and is affected by wind drift.

4. Track spacing. The most important design factor when you plan your search pattern is the determination of the distance between tracks. The following factors go into a calculation of the track spacing:

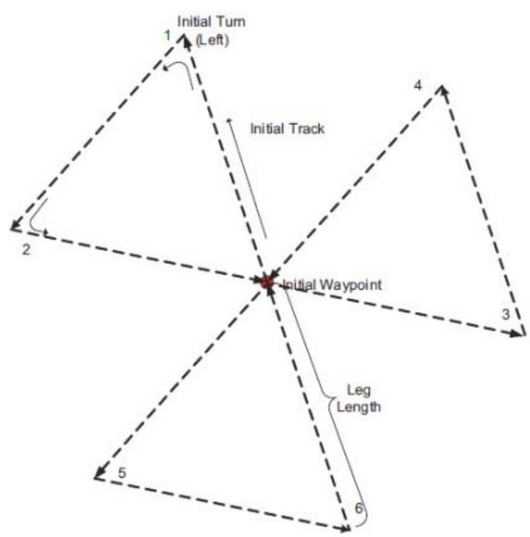
- Altitude flown
- Camera lens focal length
- Camera sensor size and image dimensions
- Speed
- Overlap in direction of flight
- Overlap in lateral directions

5. Sector search pattern. A sector search pattern is also best planned on the ground, as it involves multiple headings and precise leg lengths. Fly over the suspected location and out far enough to make a turn, fly a leg that is equal to the maximum track spacing, and then turn back to fly over the point again. This continues until the point has been crossed from all the angles.



This search pattern provides concentrated coverage near the center of the search area and provides the opportunity to view the suspected area from many angles (this minimizes terrain and lighting problems).

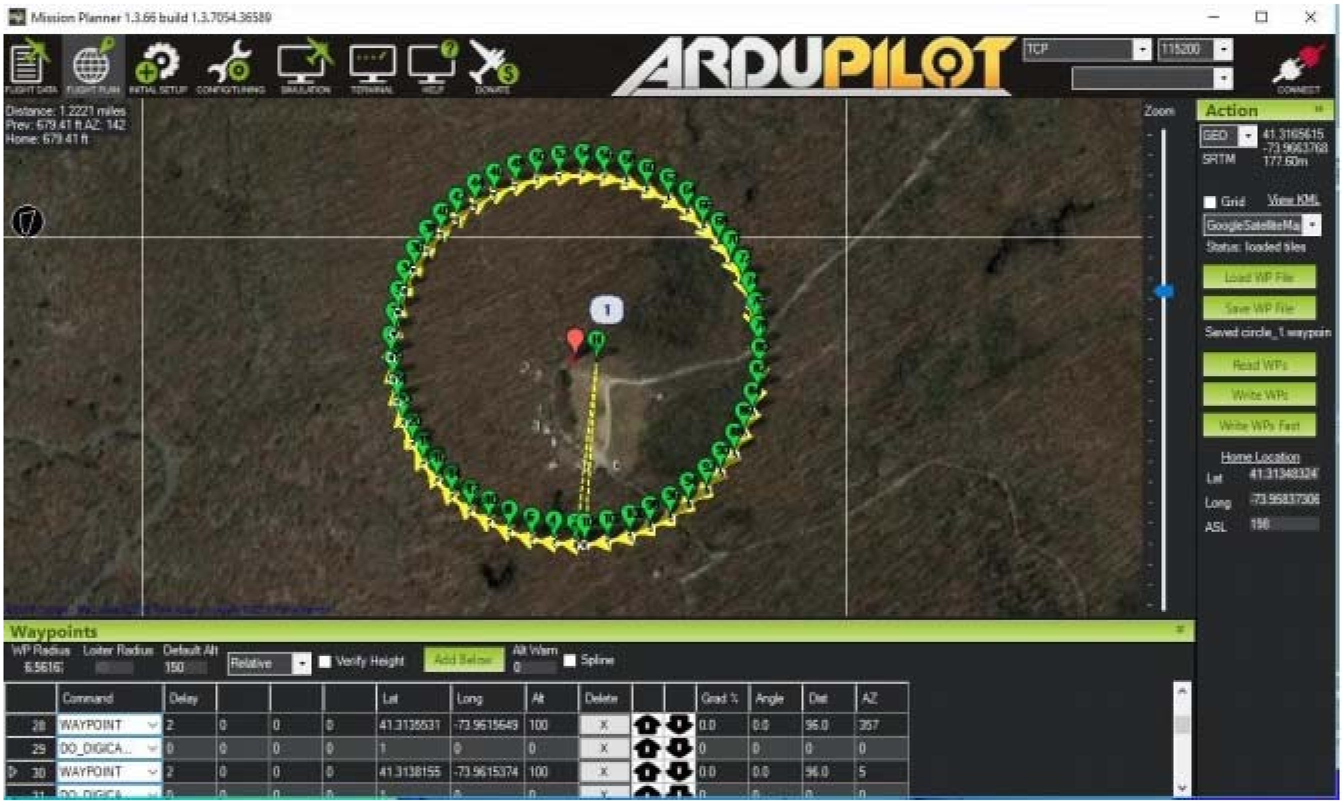
For aircraft equipped with autonomous mode, the pattern consists of three equilateral triangles (i.e., all leg lengths are equal). The default initial track is 360°, initial turn is to the left, and leg length is fixed.



6. Circle search pattern. A circle search pattern may be used when you have a prominent ground reference. The pilot executes a series of 'turns around a point' (circles of uniform distance from a ground reference point). Once the first circle is flown move outward by the desired track spacing and repeats the maneuver. This pattern is usually only used to cover a very small area, which is dependent upon search visibility (you must be able to

see the ground reference). Its benefit is that you only need to be able to locate and see the ground reference point, and no prior planning is needed. However, you must constantly correct for the wind.

The following screen shot shows a circle aerial photography mission designed in Mission Planner's Flight Planning feature. All of the parameters for the circle search can be specified. In the example, 50 photos will be taken of the Point of Interest from positions on the circular track.



Additional Information

Search patterns are covered in MP Tasks O-2102 thru O-2105 and may be combined in any fashion. More detailed information and figures on this topic are available in Chapter 8 of the MART Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text.

Practice

Setup: Give the student an expanding square or sector search to plan and fly. The student should have a sectional chart, plotter, and worksheets as needed or Mission Planner software.

Two kinds of expanding square searches should be practiced: one aligned with the cardinal points, and the other aligned 45º from the cardinal points.

The student will enter and fly the pattern long enough to demonstrate proficiency in all aspects of the search. Search altitude, airspeed and track spacing should be selected to match terrain and conditions: 200' AGL, 10 knots, and 300' track spacing is recommended.

Depending on the level of proficiency of the pilot, one or more of these tasks may be practiced simultaneously:

Planning. All mission flights must be thoroughly planned: this ensures the pilot and crew can accomplish the mission objectives safely and precisely. Treat each flight as if it were an actual mission. Each time the student practices a flight all required paperwork and WMIRS entries should be completed as part of the drill. The student should sign herself and the aircraft into the mission, receive her assignment from you (the Briefing Officer), plan the flight, and complete the Planning and Briefing sections in WMIRS. Review the ORM, W&B, battery assumptions, and information entered into WMIRS thoroughly or on paper.

Preflight and pilot briefings. Ensure the student performs a thorough preflight of the aircraft. Acting as a crewmember, receive pilot safety and mission briefings from the student. Perform safety assignments as directed by the student (e.g., collision avoidance during taxi and in flight).

Initial training. Depending on the proficiency and skills of the student, the training pilot may need to demonstrate all aspects of a point search. This gives the student time to absorb the information and work on such skills as setting up, entering data, and using the navigational equipment without the added responsibilities of the PIC.

For each practice sortie, watch for:

1) Proper configuration of the UAS.]

2) Stabilized entry into the search area. The aircraft should be at search altitude and airspeed at least 30 seconds before entering the search area.

3) Accurate and precise navigation. The student should maintain altitude, airspeed and track in the search area. Watch for proper wind drift correction and airspeed adjustments. Ensure the turns are started soon enough to stay inside the search area without requiring abrupt turns.

4) Safety. The student should spend most of her time looking at the aircraft (see and avoid). Initially, the student will spend too much time with her eyes on the control station. Get the student into the habit of not looking away from the aircraft for more than five seconds at a time to manipulate communications and navigational equipment.

Evaluation Preparation

Setup: Give the student an expanding square or sector search to plan and fly. The trainee will choose the program or app that applies to the UAS being flown.

The student will enter and fly the pattern long enough to demonstrate proficiency in all aspects of the search. Search altitude, airspeed and track spacing should be selected to match terrain and conditions: 200’ AGL, 10 knots, and 300’ track spacing is recommended.

Run the sortie as it would be during an actual mission. Have the student sign in, sign in the aircraft, and complete all required paperwork. Brief and debrief the sortie as if you were the Briefing/Debriefing Officer during a mission.

During the flight the camera gimbal will be set to nadir position (perpendicular to the ground). The camera will be set to take pictures at 3 second intervals. At the conclusion of the flight, the memory card will be turned in to download images for the flight. Student will use images to demonstrate knowledge of image processing for orthomosaic images.

Brief Student: You are a Mission Pilot trainee asked to plan and fly a point-based search.

Evaluation

Performance measures:	Results	
1. Sign yourself and your aircraft into the mission.	P	F
2. Receive a sortie briefing, asking questions as necessary.	P	F
3. Plan a point-based search (expanding square or sector). Include: a. Estimated time enroute, time in the search area, and battery requirements. b. Position coordinates for the entry and exit points. c. Position coordinates for the legs. d. Altitude restrictions, obstacles and other hazards. e. Discuss observer/scanner assignments for all possible combinations.	P	F
4. Fill out the Flight Plan and Briefing sections in WMIRS.	P	F
5. Preflight the aircraft and perform pilot safety and mission briefings.	P	F
6. Demonstrate and discuss safety during each critical phase of the flight. In particular, demonstrate collision avoidance and enforce sterile cockpit rules.	P	F
7. Setup the CAP FM radio and perform all required radio reports (may be simulated).	P	F
8. Fly the point-based (expanding square or sector) search. Demonstrate: a. Proper use of navaids. b. Proper use of radios. c. Entry at the proper point, stabilized at search altitude and speed. d. Accurate altitude and speed control inside the search area. e. Turns accomplished accurately and smoothly. f. Accurate navigation and track spacing. g. Proper observer/scanner assignment (may be simulated).	P	F
9. Demonstrate proper attention to battery management.	P	F
10. Properly secure the aircraft at the end of the flight (ready for next flight).	P	F
11. Fill out the Debriefing section in WMIRS and debrief the sortie.	P	F
12. Successfully collected imagery from flight - Removed Memory card	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5019

Plan and Command a CAP UAS Flight

CONDITIONS

You are a sUAS Mission Pilot trainee and must plan and command a CAP flight.

OBJECTIVES

Plan and command a CAP sUAS flight. Perform preflight tasks and briefings, perform briefings for all critical phases of the flight, ensure mission sortie objectives are met, and perform after-landing tasks and debriefing.

TRAINING AND EVALUATION

Training Outline

1. As a Mission Pilot trainee, knowing the mission pilot's responsibilities during each phase of flight so as to command the flight is essential. In all cases follow the aircraft checklists: the Technician should read each item to you and then you will either perform or repeat back performance of the item.

   CAP resources should be considered National Security assets. In times of emergency you should take special security precautions to protect the UAS and crew. Some examples are:

   - Securely store your UAS in a locked or closed space. You may place small pieces of clear tape on battery covers, storage cases and/or doors that will break if someone tampers with vital areas.

   - Pay particular attention during preflight inspections. Look for signs of tampering and carefully inspect the components for damage.

   - Be as "low key" as possible and be discrete. Don't discuss CAP business in public places.

   - Be aware of your surroundings at all times. If you see something or someone that is suspicious, don't ignore it. Report your suspicions to your supervisor and/or law enforcement.

2. **Prior to Startup**

   For every CAP flight the PIC must ensure the crew is wearing a proper CAP uniform (CAPM 39-1) and is carrying a current CAP Membership card. Each crewmember must be safety current (eServices).

   a. Fill out/update the Planning and Briefing sections of the sortie in WMIRS or on paper forms (including ORM and W&B), review any aircraft discrepancies, and get a briefing and flight release. Fill in all required information on the aircraft Flight Log.

   b. Recheck the Discrepancy and Maintenance Logs in the UIF to ensure the UAS is airworthy and mission ready. When you preflight, verify these discrepancies; if you find a new discrepancy, log it and assess airworthiness and mission readiness.

   c. During loading, ensure that all payloads correspond to what was used in the W&B, and review determine battery capacity assumptions (e.g., rate, winds, power setting, and distance) and reserve (CAPR 70-1U requires planning to have a minimum of 20% battery capacity remaining upon landing, computed at normal battery consumption).

d. Airframe is undamaged, propellers have no nicks or notches, and all payloads and sensors are secure.

e. Ensure your navigational databases, aeronautical charts, weather reports, TFRs and NOTAMs, K index is current, and maps are current.

f. Make sure the launch area is clear of obstacles, unassociated people, and other traffic; arrange for additional UAS Technicians if additional eyes are needed to see around obstacles.

3. Motor Startup

Aircraft checklists

a. Always use checklists in CAP aircraft. Whenever possible, have the UAS Technician read the checklist items to you while you either perform or repeat back accomplishment of each item.

b. Make sure you or the UAS Technician keeps the checklist close at hand so that it can quickly be opened to confirm and complete emergency items. Brief the UAS Technician on how to use the emergency checklists (e.g., read the bold face items first and then continue with the rest of the items).

c. Perform the aircrew briefing, brief battery assumptions, brief crewmembers on their assignments, and assure that GPS lock has been achieved

d. All crewmembers must wear their safety garments at all times, especially during takeoff and landing.

Startup

a. Synch the Control Station and UAS and signal the UAS Technician before starting the motors. Announce "Clear" prior to starting motors, and wait for response, "Clear" from entire aircrew.

b. Once the motors are started the sterile cockpit rules begin; all unnecessary talk is suspended, and collision avoidance becomes the priority of each crewmember. Sterile cockpit rules focus each crewmember on the duties at hand, namely concentrating on following the aircraft, and looking for obstacles and other aircraft. The rules will always be used during the startup, takeoff, departure, approach, and landing phases of flight; but the Mission pilot or UAS Technician may declare these rules in effect whenever they are needed to minimize distractions.

4. Takeoff, climb and departure

Takeoff

a. Ensure you are within wind limits of the aircraft's POH.

Climb

a. Keep your emergency checklist close at hand and open to the Emergency Procedures section.

Departure

a. Maintain sterile cockpit until well clear of traffic and obstacles and keep the crew apprised of conflicting traffic and obstacles.

b. Maintain situational awareness.

5. Fly the Sortie Pattern(s)

<u>Transit to the Search Area</u>

a. Relax sterile cockpit rules.

b. Maintain situational awareness.

c. Double-check navigational settings to be used in the search area.

d. Review search area terrain and obstacles.

e. Keep aware of in-flight weather.

f. Review methods to reduce fatigue during the search.

<u>Approaching the Search Area</u>

a. Review search objectives.

b. Double-check telemetry and navigational settings

c. Stabilize at search heading, altitude and airspeed; sterile cockpit.

d. Evaluate the scene (situational awareness) for conflicting traffic.

<u>In the Search Area</u>

a. Log time and report "In the Search Area".

b. Enter deviations from assigned search parameters in Technician's Observer Log.

c. 5 minute updates - Altimeter and battery assumptions.

d. Report "Operations Normal" at assigned intervals.

e. Maintain between 200 and 400 feet altitude AGL during daylight.

f. Maintain at least 300 feet altitude AGL during authorized nighttime flights.

g. Monitor for crew fatigue.

h. If you sight the objective, notify mission base at once.

i. Log all "negative result" sightings and review all photos (reshoot if necessary).

Departing the Search Area

a. Log time and report "Out of the Search Area".

b. Double-check heading and altitude assigned for transit to next search area or return to base.

6. Approach, descent and landing

Approach

a. Sterile cockpit rules are now in effect.

b. Remind the crew that collisions are most likely to occur in daylight VFR conditions near the landing zone of a flying field at or below 300’ AGL!

Descent

a. Be alert for vortex ring state and correct if necessary.

Landing and shutdown

a. Defer the post flight checklist until the UAS is on the landing pad.

b. Set the Control Station down and Power off the UAS. Then power off the control station.

7. Post-flight

a. Fill in all remaining information on the aircraft Flight Log. Double-check entries for mission symbol, mission number, crew names, and FRO name. Enter any new problems into the Discrepancy log.

b. If this was the last flight of the day, return the UAS to its packing case after the postflight checklists are completed

c. Remove the battery and secure the camera gimbal.

d. Check the general condition of the UAS airframe, sensors, payloads, and camera. Check the condition of the props before you put them away. Replace a prop if it is nicked or cracked.

e. Sign off any tasks that were completed on the crew's SQTRs..

8. Debrief

a. Take a short break and then meet to complete the Debriefing portion of your sortie in WMIRS or paper forms

b. Fill in or verify 'ATD' and 'Actual Landing Time'.

c. The Summary section describes what you accomplished on the sortie.

d. The Results/Deliverables section can be as simple as "no sightings" or "no damage noted." However, you must list results such as sightings (including negative sightings), the number of photos you took, etc.

e. The Weather Conditions section can be as simple as entering "as forecast." However, if the weather was unexpected it is important to explain how the weather conditions affected sortie effectiveness.

f. The Remarks section is for entering any information you think is pertinent or helpful that was not entered elsewhere in WMIRS. It also gives the crew a chance to comment on the effectiveness of the sortie in detail.

g. The Sortie Effectiveness section involves a quantitative assessment of how well you accomplished your mission.

h. The Attachments & Documentation section is self-explanatory. Ensure all entries and sketches/drawings are clear and legible and upload into WMIRS. Be sure to label each attachment (e.g., mission and sortie number) so they can be related to the mission/sortie if it accidentally becomes separated.

i. Process Memory card images if necessary.

j. Turn in/upload photos and/or video

k. Log battery usage and condition in Battery Management log.

Check in with Debriefing Officer

a. Tell how you did your job and what you saw.

b. Usually starts with a review of the information you entered on the CAPF 109.

c. Answer all questions as best you can, and be very honest about conditions and your actions.

d. If you are scheduled for another sortie, find someplace to rest. Close your eyes; you may even want to take a nap if there is time and a place to do so. Also, take in some refreshment to give you sufficient energy for the next sortie.

e. Ensure that the air crew obtains sufficient rest during crew rest periods, including approval of extensions to the maximum air crew duty period (CAPR 70-1U).

Additional Information

This task should serve as a "final check" prior to taking a CAPF 91U check flight. As such, this flight should be performed on an official exercise if possible. The student should make all required entries and uploads in WMIRS or paper records.

More detailed information on this topic is available in FAR 91 Subpart C, CAPRs 70-1U and 66-1, and Chapters 9 & 10 of the MART Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text; the "Mission Checklist" in Attachment 2 summarizes the steps listed in this task guide.

Practice

Setup: Give the student a mission sortie to plan and fly. The flight should include one or two of the required search patterns. The student should have access to WMIRS and all required CAP regulations and forms, mission materials and logs.

The student will fly long enough to demonstrate proficiency in all aspects of the flight.

The evaluator should play the role of an aircrew member, particularly for receiving briefings and instructions from the UAS mission pilot trainee.

Depending on the level of proficiency of the pilot, one or more of these tasks may be practiced simultaneously:

Planning. All CAP flights must be thoroughly planned: this ensures the pilot and crew can accomplish the flight safely. Review the Weight and Balance, battery assumptions and ORM thoroughly.

Preflight and crew briefings. Ensure the trainee performs a thorough preflight of the aircraft. Acting as a crewmember, receive pilot safety and crew briefings from the student. Perform safety assignments as directed by the student (e.g., collision avoidance during takeoff and in flight).

Equipment. To the extent possible, the student should operate the communications and navigation equipment. The student should confirm the GPS lock prior to takeoff. [Where necessary for safety or training, the evaluating pilot may take over the aircraft controls if the student is focused on sensors or telemetry.

For this flight, watch for:

1) Thorough knowledge of aircraft and CAP regulations, logs and paperwork.
2) Proper use of checklists during all phases of flight.
3) Accurate and thorough planning for all critical phases of flight.
4) Thorough briefings to the crew during all phases of flight.
5) Proper use of sterile cockpit rules and collision avoidance techniques.
6) Situational awareness and proper attention to battery status and altitude.
7) Proper shutdown, inspection, securing and cleaning of the aircraft after flight.
8) Thorough and honest debrief
9) Complete and accurate entries in WMIRS or on paper forms.

Evaluation Preparation

Setup: Give the student a flight to plan and fly. The flight should include one or two of the required search patterns. The student should have access to WMIRS and all required CAP regulations and forms, mission materials and logs.

The student will fly long enough to demonstrate proficiency in all aspects of the flight.

Brief Student: You are a Mission Pilot trainee asked to plan and fly a mission sortie.

Evaluation

Performance measures:	Results	
1. Check Weight & Balance, battery requirements and state battery reserve.	P	F

2. Complete an Operational Risk Management worksheet for the flight. P F

3. Discuss basic airfield or launch site security precautions. P F

4. Complete the Planning and Briefing sections in WMIRS or on paper form. P F

5. Receive a briefing and obtain a flight release. P F

6. Aircraft preflight: P F
   a. Verify W&B assumptions.
   b. Complete Preflight checklist.

7. Prior to startup: P F
   a. Fill in Aircraft Log.
   b. Perform crew briefings, and assign responsibilities.
   c. Determine wind and crosswind, and state limits.

8. Startup: P F
   a. Setup the UAS control station and software for the flight.

9. Takeoff, departure, approach, decent and landing: P F
   a. Demonstrate challenge-response method for checklists.
   b. Demonstrate proper collision avoidance procedures.
   c. State and enforce sterile cockpit rules.
   d. Maintains situational awareness at all times.
   e. Demonstrate proper attention to battery status and altitude.

10. After landing: P F
    a. Fill out the Aircraft Log and enter discrepancies (if necessary).
    b. Properly shutdown, inspect, secure and pack the UAS (as if last flight of the day).

11. Debriefing P F
    a. Complete the Debriefing section in WMIRS.
    b. Complete a Debriefing

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5020

Demonstrate Preparation for a Trip to a Remote Mission Base

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must prepare for a trip to a distant mission base.

OBJECTIVES

Prepare for a trip to a distant mission base that is in Class B airspace, acting as both aircraft and mission commander. Perform pre-trip planning and inspections, file an FAA Flight Plan (simulated), complete the Operational Risk Management (ORM) worksheet, complete a Weight & Balance (W&B), perform preflight tasks, and obtain a CAP flight release (simulated). This task focuses on mission planning and briefing, and allows the student to show familiarity with mission practical and regulatory requirements and to demonstrate WMIRS proficiency. This task should be completed before MP O-2008 (Complete a Mission Sortie) or MP O-2102 -2105 (planning and flying search patterns).

TRAINING AND EVALUATION

Training Outline

1. As a Mission Pilot trainee, the ability to prepare for a trip to a remote mission base is essential. Use the Mission Checklist in Attachment 2 (CAP *Flight Guide*) or similar checklist (e.g., the *In-Flight Guide and Aircrew Aid*) as necessary.

2. *Before you leave.* The urgency of events, coupled with a hasty call-out, may leave you and other crewmembers feeling rushed as you prepare to leave for a mission. This is where a good mission checklist comes in handy. As a minimum, check the crew (and yourself) for the following:

    a. Check proper uniforms (CAPM 39-1) and credentials of aircrew.
        1) CAP Membership
        2) CAP Driver's License (on CAPF 101), if applicable
        3) CAPF 101/SQTR (note experience and tasks to be accomplished)
        4) Aircrew safety currency (eServices); Pilot currency

    b. Check personal equipment.
        1) Clothing sufficient and suitable for the entire trip
        2) Personal supplies (civilian clothing, headset, charts, maps, plotter, log, checklists, fluids and snacks)
        3) Personal survival equipment (in addition to the vehicle kit) suitable for the entire trip
        4) Sufficient money for the trip
        5) Cell phone (including spare battery and charger) and tablet

    c. Check aircraft equipment.
        1) Current Aeronautical Charts for the entire trip and gridded charts for the mission area
        2) Maps for the mission area (e.g., road atlas, county maps, topo maps), plus clipboard and markers
        3) Check special equipment (e.g., computer, camera, portable GPS, spare batteries)
        4) Survival kit (fits trip and mission area terrain), headsets, flashlight, binoculars and multi-tool

    d. Review the Aircraft Logs.
        1) Note the date and the starting flight times

   2) Check the status of the Fire Extinguisher, if carried
   3) Review the Discrepancy Log (WMIRS) and make sure the aircraft is airworthy and mission ready

   NOTE: It is important for the mission pilot to understand how to find data in aircraft logbooks. Familiarize yourself with your aircraft's airframe and battery logbooks.

e. FAA Weather Briefing and CAP Flight Release.
   1) Perform Weight & Balance
      a) Ensure battery reserve of at least 20%
   2) Complete ORM worksheet in WMIRS
   3) Complete the Planning and Briefing sections of your inbound sortie in WMIRS including discrepancy check
   4) Verify aircrew within duty period/crew rest limitations of CAPR 70-1U
   5) Brief the crew on your battery management plan
   6) Review "IMSAFE" or equivalent and obtain CAP Briefing/Flight Release [Simulate the release]

f. Preflight.
   1) Ensure proper entries in the aircraft Flight Log [Use a copy; otherwise simulate]
   2) Check starting flight time
   3) While preflighting, verify any outstanding discrepancies. If new discrepancies discovered, log them and ensure the aircraft is still airworthy and mission ready. [Be extra thorough on unfamiliar aircraft.]
   4) Verify payload is operational
   5) Double-check navigational databases (include EFB/ECD), aeronautical charts, and maps
   6) Perform crew briefing and review emergency procedures
   7) Remind crew that most midair collisions occur in or near the traffic pattern
   8) Enter settings into flight planning app if used (e.g., imagery or search pattern, entry points and waypoints)
   9) Use checklists to ensure all necessary equipment is present and accounted for.

Additional Information

More detailed information and figures on this topic are available in Chapters 9 & 10 and Attachment 2 of the MART Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text.

Practice

Setup: Give the student an assignment to take a crew to a remote mission base. The student should have access to mission materials and aircraft logs, a CAPF 71U, and WMIRS (or paper forms).

The student will plan and obtain a briefing and flight release for a trip to a remote mission base. All tasks that can be performed will not be simulated, as this task provides the opportunity to thoroughly discuss mission preparatory actions and to demonstrate the ability to enter planning and briefing information into WMIRS (including completion of the ORM worksheet and upload of the W&B).

For this simulated sortie, watch for:

1) Thorough knowledge of documents and equipment required for an extended stay at a remote base.
2) Thorough knowledge of aircraft and CAP logs and paperwork
3) Accurate and thorough planning for the trip

4) Accurate completion of the ORM worksheet, W&B, and planning and briefing information in WMIRS.
5) Ensure the student performs a thorough preflight of the UAS and support items. Acting as a crewmember, receive pilot safety and mission briefings from the student.

Evaluation Preparation

Setup: Give the student an assignment to take a crew to a remote mission base. The student should have access to mission materials and aircraft logs, applicable sectional chart(s) and weather data (may use digital files), WMIRS, and a CAPF 71U.

All tasks that can be performed will not be simulated. [Simulate the CAP Flight Release, and delete the sortie created in WMIRS when finished.]

The trainer will play the role of the aircrew members, particularly for receiving inspections, briefings and instructions from the mission pilot trainee. The trainer will act as the CAP Briefing Officer, and the CAP Flight Release Officer. The trainer may enter a sortie in WMIRS, or let the student do it.

Brief Student: You are a Mission Pilot trainee asked to prepare for a trip to a remote mission base.

Evaluation

Performance measures:	Results	
1. Check for proper uniform, credentials and equipment.	P	F
2. Discuss minimum personal equipment.	P	F
3. State the flight time and duty limitations per CAPR 70-1U.	P	F
4. Check the aircraft:	P	F
a. After doing an aircraft inspection, state battery requirements, assumptions and reserve		
b. Check for required equipment to complete a mission.		
5. Fill in Planning and Briefing information in WMIRS, obtain a CAP flight release.	P	F
a. ORM worksheet.		
b. Check discrepancies.		
6. Brief the crew:	P	F
a. Flight management plan (assumptions, battery requirements and mission deliverables).		
b. NOTAMS and anticipated weather problems.		
c. ORM		
d. Crew briefing and emergency procedures.		

7. OPTIONAL: Discuss Go-No Go decision making. P F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

O-5022

Demonstrate Maintaining Visual Observation of UAS

CONDITIONS

You are a UAS Mission Pilot trainee and must train a UAS Technician as your Visual Observer.

OBJECTIVES

This task will cover the role of a UAS Technician acting as Visual Observer (VO) in UAS flights, and how to make sure your UAS Tech is sufficiently trained. First, we'll discuss what a UAS Tech is and why you are required to have one, and then we'll take a deep dive into how to train a UAS Tech. A UAS Technician is a required crew member for a flight mission who serves as a second set of eyes, monitoring the UAS in flight in order to support the Remote Pilot in Command (PIC). Although a VO is not required by the FAA for regular UAS missions—missions where the PIC is maintaining a direct visual line of sight with his or her UAS—having one is certainly useful, and can help lessen the stress of a flight. In Civil Air Patrol UAS flight operations a UAS Technician will act as a Visual Observer and perform other tasks to assist the Pilot in Command.

TRAINING AND EVALUATION

Training Outline

1. Why Use a Visual Observer? The main reason to use a UAS Tech as a Visual Observer is for greater situational awareness during a flight. While the pilot needs to look back and forth from a screen, to the sky, to his or her hands, the UAS Tech can be there maintaining a line of sight with the UAS at all times, ensuring that even in those micro-moments where the pilot has to look away the UAS is still flying safely. It's important to emphasize that the role of a UAS Tech is not simple.

Just having an untrained observer standing nearby watching your UAS in flight doesn't cut it. If someone is performing the role of UAS Tech, it's important that he or she be properly trained. Just imagine the difference between someone frantically shouting, "Look out, a thing is flying somewhere nearby!" and someone calmly telling you, "Bird, twelve o'clock high, moving slowly away."

2. Training Your Visual Observer. To simplify this training, here is an outline so you can see how this information is organized:

What situations call for a UAS Tech?
a. Restricted Airspace
b. General UAS Technician Responsibilities
c. UAS Technician Scanner Responsibilities
d. UAS Technician Visual Observer Responsibilities
e. How to Scan the Sky
f. UAS Technician Positioning
g. Pre-Flight Procedures
h. Communicating During a Flight

3. What Situations Call for a UAS Technician Observer? A UAS Tech is a useful part of any UAS mission, but at a minimum we recommend that they be used in the following situations:

a. Where ground objects present hazards.
b. Where varied terrain or other factors may make it difficult for the PIC to maintain a direct line of sight.
c. For any flight in restricted airspace
d. To assist the Pilot with checklists, battery management, etc.

The FAA provides guidelines on situations where a UAS Technician acting as a Visual Observer is mandatory: You must keep your UAS within sight. Alternatively, **if you use First Person View or similar technology, you must have a visual observer always keep your aircraft within unaided sight** (for example, no binoculars). However, even if you use a visual observer, you must still keep your unmanned aircraft close enough to be able to see it if something unexpected happens. Neither you nor a visual observer can be responsible for more than one unmanned aircraft operation at a time.

4. **Restricted Airspace.** Regarding restricted airspace, for missions being flown with special airspace authorization we recommend that, wherever possible, two UAS Technicians acting as visual observers assist the PIC. For restricted airspace missions, the two types of UAS Techs as observer it is suggested that you have in place 1) A UAS Tech acting as a Scanner, and 2) A UAS Tech acting as Visual Observer.

   The Scanner's role is to scan the skies and ground constantly, ensuring that the flight path and surrounding area is free of potential obstacles.

   The Observer's role is to maintain a visual line of sight with the sUAS at all times. The Drone VO should always be ready to share the location of the drone with the PIC in case he or she ever loses the line of sight.

5. **General UAS Tech Observer Responsibilities.** Simply put, the VO helps the PIC by communicating crucial information needed to ensure the safe operation of the drone. Here is a list of general responsibilities for a UAS Technician:

   UASTs should know about the scenarios that can impact flying conditions, including weather conditions, ground hazards, and airborne hazards.

   UASTs should be aware of the FAA's Small Unmanned Aircraft (or Part 107)

   Regulations regarding flights over people and other prohibited activities, and support the PIC in flying within the bounds of what is legally permissible.

   UASTs not only need to be able to identify issues in the sky, but direct the PIC to take the action necessary to avoid those issues.

   UASTs should constantly scan the skies and the ground to identify potential hazards, and notify the PIC of those hazards as they arise.

   It's crucial for the PIC to trust the UAS Technician's judgment, and immediately act on their advice without question. For this to happen the PIC must trust the UAST, and the UAST must honor that trust by providing accurate, timely information.

6. **UAS Technician Scanner Responsibilities.** For flights in restricted airspace, we recommend using a Scanner VO and a Drone VO. The responsibility of the Scanner VO is to continually scan the skies, looking for any potential safety hazards. The Scanner VO is also responsible for observing the ground and identifying anything there that could

be of concern for the mission. If the Scanner VO sees people approach during an ongoing mission, it is his or her job to let them know that a drone is being flown nearby, and to ask them to clear the area.

7. **UAS Technician Observer Responsibilities.** The responsibility of the UAS Observer is to maintain visual contact with the drone being flown at all times. The General VO Responsibilities section above provides more information, excluding the final bullet point about scanning the skies and ground (which will be the job of the Scanner VO).

8. **How to Scan the Sky.** It's important to have a procedure in place for how you're going to scan the sky so that the VO isn't simply looking all around, but is actually monitoring the airspace in a systematic manner. Here is the process we recommend for scanning the skies:

   a. Begin your scan by looking at the 12 o'clock position, high in the sky.

   b. Scan from left to right, from the 9 o'clock to the 3 o'clock positions on the clock, making sure to cover the same points / airspace the PIC is currently flying in.

   c. Then, starting at the 3 o'clock position, look down and scan back to the left 9 o'clock position. If necessary, look farther downward and scan back to the 3 o'clock position.

   d. Rotate 180 degrees to scan the 3 to 9 o'clock position, covering 3 to 9 o'clock positions that are directly behind the PIC, using the same high/medium/low sky sections.

   e. Start over and repeat.

   Of course, the Observer also needs to use common sense, and all of his or her senses. If a noise alerts the Observer to a potential hazard on the ground or in the air nearby, the cause of the noise should be identified and possible safety issues should be assessed immediately.

9. **Positioning the UAS Tech(s).** The Observer should be close to the PIC, but not physically crowding him or her. The rule of thumb here is that the PIC and Observer should be close enough that they can hear each other clearly, but not so close that there is a danger they might bump into each other. The Observer should also be at a close enough distance to the PIC to ensure that no one else bumps into the PIC. When flying in restricted airspace with two Observers, we recommend the Scanner VO stand on the right hand side of the PIC, at the 3 o'clock position, and the Drone VO stand on the left hand side of the PIC, at the 9 o'clock position. (This positioning is arbitrary — the two Observers can switch sides if that makes more sense for the mission you're flying; what's important is that each VO have a specific side.)

   Tip: The Observer should keep in mind that, regardless of his or her position, the information relayed to the PIC should correspond with the PIC's position, not the Observer's position.

10. **Pre-flight Procedures.** Before flying, the PIC should communicate with the Observer and anyone else involved in the mission regarding:

    a. Operating conditions (includes things like weather, tree cover, or uneven terrain)
    b. Emergency procedures

c. Contingency procedures
d. Roles and responsibilities
e. Potential hazards

The objectives of the flight, anticipated flight paths, and any unique potential hazards or safety issues unique to the locale of the flight should be covered by the PIC. If there are any bystanders, they should be instructed on where they can safely observe the flight. Weather should be checked, and the PIC should communicate with the Observer and discuss any conditions that might affect the flight.

The PIC should go over the anticipated flight parameters and advise the Observer of his or her responsibilities and communicate any special conditions or issues pertinent to the flight, as well as any special needs he or she might have for the specific flight.

Emergency procedures should be discussed, and possible alternate landing locations identified. Before any flight, all parties should agree that there are no outstanding issues and the flight is ready to proceed.

8. Communicating During a Flight. In general, during a mission the PIC will be flying, and the VO will be performing the duties laid out in the sections above that pertain to VO responsibilities. Here are some useful phrases to use when communicating during a flight:

Observer Phrases

"Approaching distance limit"—To be used when the VO is in danger of losing his or her line of sight with the drone.

"Distance is a go"—To be used when the PIC has moved the drone back into a range where the VO can comfortably observe it.

"Cannot locate"—To be used when the VO loses site / cannot locate the drone (the latter in response to the PIC's command "Locate drone").

"Bring it down!"—To be used when the VO determines there is imminent danger and the drone needs to be grounded immediately.

"Climb, climb, climb!"—To be used when the PIC needs to climb immediately to avoid an imminent collision.

PIC Phrases

"Preparing to launch "—To be used when the PIC is preparing to launch.

"Launching"—To be used when the PIC is launching.

"Descending"—To be used when the PIC is descending for a landing.

"Landing at new position"—To be used when the PIC is manually flying to a position that is not the original home position.

"Locate drone"—To be used when PIC loses visual contact with the drone.

If either the VO or the PIC cannot locate the drone visually for a period longer than approximately 15 seconds, the PIC should initiate the Failsafe Return to Home function of the drone and alert all observers that he or she has done so.

Communicating Location and Movement. Clock coordinates should be used for locating hazards:

12 o'clock is straight in front of the PIC.
6 o'clock is immediately behind the PIC.
3 o'clock is 90 degrees to the PIC right.
9 o'clock is 90 degrees to the PIC left.

Use the locational words "high" and "low" to indicate the distance to or from the horizon. It's also important to note both the direction and speed with which the hazard is moving by saying "moving away slowly" or "moving closer rapidly", etc. The descriptors are very important here, because they help convey the urgency of the hazard. An object moving slowly away is much less of a concern than something moving rapidly closer. Here's an example of communicating the location of a potential hazard in the sky: ***"Drone, 12 o'clock high, moving closer slowly"***

Additional Information

More detailed information on this topic is available in Chapter 5 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Provide the student access to an aircraft (may simulate on the ground).

Evaluation

Performance measures:	Results	
1. Discuss the difference between the Scanner and Observer roles.	P	F
2. Describe the responsibilities of a UAS Tech Observer	P	F
3. Explain the considerations of placing UAS Tech Observers	P	F
4. Describe some UAS Tech terminology to describe direction and location	P	F

O-5023

Participate in Planning a CAP UAS Flight

CONDITIONS

You are a UAS Mission Pilot trainee and must plan and command a CAP UAS flight.

OBJECTIVES

Plan and command a CAP UAS flight. Perform preflight tasks and briefings, perform briefings for all critical phases of the flight, ensure mission flight objectives are met, and perform after-landing tasks and debriefing.

MP O-2107 (Prepare for Trip to a Remote Mission Base) and O-2008 (Complete a Mission Flight) are related to this task. This flight should be flown on an official CAP exercise, if possible. The aircrew should consist of a Mission Pilot and one or more UAS Technicians.

TRAINING AND EVALUATION

Training Outline

1. As a Mission Pilot trainee, knowing the mission pilot's responsibilities during each phase of flight so as to command the flight is essential. In all cases follow the aircraft checklists: the UAS Technician should read each item to you and then you will either perform or repeat back performance of the item.

   CAP resources should be considered National Security assets. In times of emergency you should take special security precautions to protect the UAS and crew. Some examples are:

   - Securely store your UAS in a locked or closed space. You may place small pieces of clear tape on fuel caps, the cowling and/or doors that will break if someone tampers with vital areas.
   - Pay particular attention during preflight inspections. Look for signs of tampering and carefully inspect the fuel for contamination
   - Be as "low key" as possible, and be discrete. Don't discuss CAP business in public places
   - Be aware of your surroundings at all times. If you see something or someone that is suspicious, don't ignore it. Report your suspicions to your supervisor and/or law enforcement.

2. ***Prior to Startup*** For every CAP flight the PIC must ensure the crew is wearing a proper CAP uniform (CAPM 39-1) and is carrying current CAP Membership cards. Each crewmember must be safety current (eServices).

   a. Fill out/update the Planning and Briefing sections of the sortie in WMIRS [or paper forms] (including ORM and W&B), review any aircraft discrepancies, and get a briefing and flight release. Fill in all required information on the aircraft Flight Log.
   b. Recheck the Discrepancy and Maintenance Logs in the UIF to ensure the UAS is airworthy and mission ready. When you preflight, verify these discrepancies; if you find a new discrepancy, log it and assess airworthiness and mission readiness.

a. During loading, ensure that all payloads correspond to what was used in the W&B, and review determine battery capacity assumptions (e.g., rate, winds, power setting, and distance) and reserve (CAPR 70-1U requires planning to have a minimum of 20% battery capacity remaining upon landing, computed at normal battery consumption).
b. Airframe is undamaged, propellers have no nicks or notches, and all payloads and sensors are secure..
c. Ensure your navigational databases, aeronautical charts, weather reports, TFRs and NOTAMs, K index is current, and maps are current.
d. Make sure the launch area is clear of obstacles, unassociated people, and other traffic; arrange for additional UAS Technicians if additional eyes are needed to see around obstacles.

Additional Information

This task should serve as a "final check" prior to taking a CAPF 91U check flight. As such, this flight should be performed on an official exercise if possible. The student should make all required entries and uploads in WMIRS or paper records.

More detailed information on this topic is available in FAR 91 Subpart C, CAPRs 70-1U and 66-1, and Chapters 9 & 10 of the MART Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text; the "Mission Checklist" in Attachment 2 summarizes the steps listed in this task guide.

Evaluation Preparation

Setup: Give the student a flight to plan and fly. The flight should include one or two of the required search patterns. The student should have access to WMIRS and all required CAP regulations and forms, mission materials and logs.

The student will fly long enough to demonstrate proficiency in all aspects of the flight.

Evaluation

Performance measures:	Results	
1. Compute Weight & Balance, battery requirements and state battery reserve	P	F
2. Complete an Operational Risk Management worksheet for the flight	P	F
3. Discuss basic air field or launch site security precautions	P	F
4. Complete the Planning and Briefing sections in WMIRS or on paper	P	F
5. Receive a briefing and obtain a flight release	P	F
6. Aircraft preflight a. Verify W&B assumptions b. Complete Preflight Checklist	P	F
7. Prior to startup a. Fill in Aircraft Log b. Perform aircrew briefings, and assign responsibilities	P	F

c. Determine wind and crosswind, and state limits

8. Startup P F
   a. Setup the UAS control station and software for the flight

9. Takeoff, departure, approach, decent and landing P F
   a. Demonstrate challenge-response method for checklists
   b. State and enforce sterile cockpit rules
   c. Maintains situational awareness at all times
   d. Demonstrate proper attention to battery status and altitude

10. After landing P F
    a. Fill out the Aircraft Log and enter discrepancies (if necessary).
    b. Properly shutdown, inspect, secure and pack the UAS (as if last flight of the day).

O-5024

Demonstrate the Emergency Return to Home Procedure of the sUAS

CONDITIONS

You are a UAS Mission Pilot or UAS Technician trainee and must demonstrate how to execute the Emergency Return to Home (RTH) procedure.

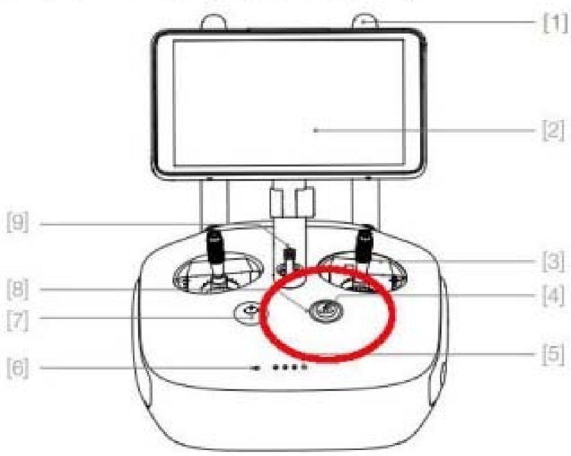
OBJECTIVES

Demonstrate how to execute the Emergency Return to Home (RTH) procedure.

TRAINING AND EVALUATION

Training Outline

Phantom 4 Pro+ (Model: GL300E)



[1] Antennas
Relays aircraft control and video signal.

[2] Display Screen
Display device with Android system to run DJI GO 4 app.

[3] Control Stick
Controls the orientation and movement of the aircraft.

[4] Return Home (RTH) Button
Press and hold the button to initiate Return to Home (RTH).

Return-to-Home (RTH)

Return-to-Home (RTH) function brings the aircraft back to the last recorded Home Point. There are three types of RTH: Smart RTH, Low Battery RTH, and Failsafe RTH. This section describes these three scenarios in detail.

	GPS	Description
Home Point		If a strong GPS signal was acquired before takeoff, the Home Point is the location from which the aircraft launched. The GPS signal strength is indicated by the GPS icon (Less than 4 bars is considered a weak GPS signal). The aircraft status indicator will blink rapidly when the home point is recorded.

⚠ • The aircraft can sense and avoid obstacles when the Forward Vision System is enabled and lighting conditions are sufficient. The aircraft will automatically climb up to avoid obstacles and descend slowly as it returns to the home point. To ensure the aircraft returns home forwards, it cannot rotate or fly left and right during RTH while the Forward Vision System is enabled.

Smart RTH

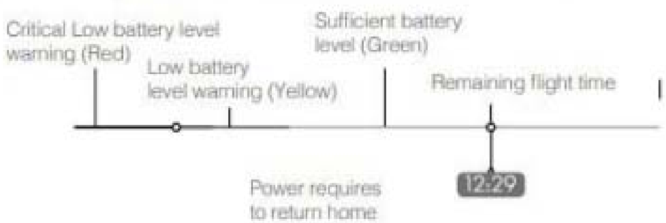
Use the RTH button on the remote controller or tap the RTH button in the DJI GO 4 app and follow the on-screen instructions when GPS is available to initiate Smart RTH. The aircraft will then automatically return to the last recorded Home Point. Use the remote controller to control the aircraft's speed or altitude to avoid a collision during the Smart RTH process. As the aircraft returns, it will use the primary camera to identify obstacles as far as 300m in front, allowing it to plan a safe route home. Press and hold the Smart RTH button once to start the process, and press the Smart RTH button again to terminate the procedure and regain full control of the aircraft.

Low Battery RTH

The low battery level failsafe is triggered when the DJI Intelligent Flight Battery is depleted to a point that may affect the safe return of the aircraft. Users are advised to return home or land the aircraft immediately when prompted. The DJI GO 4 app will display a notice when a low battery warning is triggered. The aircraft will automatically return to the Home Point if no action is taken after a ten-second countdown. The user can cancel the RTH procedure by pressing the RTH button on the remote controller. The thresholds for these warnings are automatically determined based on the aircraft's current altitude and distance from the Home Point.

The aircraft will land automatically if the current battery level can only support the aircraft long enough to descend from its current altitude. The user can still use the remote controller to alter the aircraft's orientation during the landing process.

The Battery Level Indicator is displayed in the DJI GO 4 app, and is described below:



Battery level Indicator

Battery Level Warning	Remark	Aircraft Status Indicator	DJI GO 4 App	Flight Instructions
Low battery level warning	Battery power is low. Land the aircraft.	Aircraft status indicator blinks RED slowly.	Tap "Go-home" to have the aircraft return to the Home point and land automatically, or "Cancel" to resume normal flight. If no action is taken, the aircraft will automatically go home and land after 10 seconds. Remote controller will sound an alarm.	Fly the aircraft back and land it as soon as possible, then stop the motors and replace the battery.
Critical Low battery level warning	The aircraft must land immediately.	Aircraft status indicator blinks RED quickly.	The DJI GO 4 app display will flash red and the aircraft will start to descend. The remote controller will sound an alarm.	Allow the aircraft to descend and land automatically.

Failsafe RTH

The Forward Vision System allows the aircraft to create a real-time map of its flight route as it flies. If the Home Point was successfully recorded and the compass is functioning normally, Failsafe RTH will be automatically activated if the remote controller signal is lost for more than three seconds. The aircraft will plan its return route and retrace its original flight route home. The aircraft will hover for 10 seconds at its current location. When it regains signal connection it will wait for pilot commands. The Return-to-Home process may be interrupted and the pilot given control of the aircraft if the remote controller signal connection is re-established.

Failsafe Illustration

⚠ • Aircraft cannot return to the Home Point when GPS signal is weak ([ ] displays grey) or unavailable.
- Aircraft automatically descends and lands if RTH is triggered when the aircraft flies within a 65 feet (20 meters) radius of the Home Point. Aircraft will stop ascending and immediately return to the Home Point if you move the left stick if the aircraft reaches 65 feet (20 meters) altitudes or beyond during Failsafe.
- The aircraft cannot avoid obstruction during Failsafe RTH if Forward Vision System is disabled. It is important to set a suitable Failsafe altitude before each flight. Launch the DJI GO 4 app, enter "Camera" and tap to set the Failsafe Altitude.
- User cannot control the aircraft while the aircraft is ascending to 65 feet (20 meters) from the current altitude. However, user can press RTH button once to exit ascending and regain control.

Additional Information

Obstacle Avoidance During RTH

Aircraft can now sense and actively attempt to avoid obstacles during RTH, provided that the lighting conditions are adequate for the Forward Vision System. Upon detecting an obstacle, the aircraft will act as follows:

1. The aircraft will use the primary camera to identify obstacles as far as 984 feet (300 meters) in front, allowing it to plan a safe route home.
2. The aircraft decelerates when an obstacle is sensed at 49 feet (15 meters) ahead.
3. The aircraft stops and hover then start ascending vertically to avoid the obstacle. Eventually, the aircraft will stop climbing when it is at least 16 feet (5 meters) above the detected obstacle.
4. Failsafe RTH procedure resume, the aircraft will continue flying to the Home Point at the current altitude.

- The Obstacle Sensing function is disabled during RTH descent. Proceed with care.
- To ensure the aircraft returns home forwards, it cannot rotate during RTH while the Forward Vision System is enabled.
- The aircraft cannot avoid obstacles above, beside, or behind the aircraft.

Evaluation

Setup: The student will complete a mission flight, acting as both aircraft and mission commander. The student should have access to typical mission base materials and a UAS. The mission flight will consist of a vertical takeoff to 50', some basic flight maneuvers, followed by a flight the the wind sock (or center of the flying field) at 50' altitude, hover at position for 10 seconds, and then invoke the RTH function by pressing and holding the Return to Home button.

The student will discuss (or perform) required actions during the flight, secure the aircraft upon return, perform an aircrew debriefing, and fill out the Debriefing section in WMIRS or on paper. All tasks that can be performed will not be simulated.

The trainer should play the role of UAS Technician (Observer) during the flight, receiving instructions from the student and providing feedback as necessary to complete task objectives.

During post-flight and pilot debriefing, ensure that the student completes aircraft and mission paperwork. The trainer will then play the role of Debriefing Officer and debrief the student, checking WMIRS or paper records, for accuracy and completeness.

Brief Student: You are a Mission Pilot trainee asked to complete a sortie.

Performance measures: Results

1.	Describe or perform vertical takeoff to 50’	P	F
2.	Perform standard flight maneuvers over traffic cones	P	F
3.	Execute Return to Home function	P	F
4.	Monitor Landing and take control if necessary	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5100

Discuss UAS Mission Pilot Duties and Responsibilities

CONDITIONS

You are a sUAS Mission Pilot trainee and must discuss sUASMP duties and responsibilities.

OBJECTIVES

Discuss sUAS Mission Pilot duties and responsibilities.

TRAINING AND EVALUATION

Training Outline

1. As a Mission Pilot trainee, knowing your duties and responsibilities is essential.

2. The first and foremost duty of a mission pilot is to fly the aircraft in a safe and proficient manner, following all applicable FAA and CAP rules and regulations. All other duties are secondary to those of the aircraft commander.

3. The second most important duty of a mission pilot is to remember that he or she is the pilot. You are the Remote Pilot-in-Command (PIC) and you must never forget that. The remote PIC is directly responsible for and is the final authority as to the operation of the sUAS conducted under 14 CFR Part 107. He or she must:

   a. Be designated before each flight (but can change during the flight).

   b. Ensure that the mission poses no undue hazard to people, aircraft or property in the event of a loss of control of the aircraft for any reason.

   c. Operate the small unmanned aircraft to ensure compliance with all applicable provisions and regulations.

4. Being able to safely operate the sUAS relies on, among other things, the physical and mental capabilities of the remote PIC, person manipulating the controls, mission technician, and any other direct participant in the sUAS operation. Though the person manipulating the controls of a sUAS and MT are not required to obtain an airman medical certificate, they may not participate in the operation of a sUAS if they know or have reason to know that they have a physical or mental condition that could interfere with the safe operation of the sUAS.

5. In addition to PIC duties, your general duties and responsibilities include:

   a. Obtain complete briefings and plan the sortie. A good mission pilot always includes the technician during these activities. Remember, you may be the aircraft commander, but you are not always the mission commander; an experienced mission technician could serve as mission commander whenever the pilot is in a training status.

   b. Thoroughly brief the crew before the flight.(include battery management).

   c. Thoroughly brief the crew on their responsibilities during all phases of the flight.

   d. Obtain a flight release (including one from mission base if AFAM).

   e. Enforce sterile cockpit rules.

f. Fly search patterns as completely and precisely as possible. Report any deviations from the prescribed patterns during debriefing.

g. Monitor the technician and ensure all events, sightings and reports are recorded and reported.

h. Fill out all forms accurately, completely and legibly.

i. Ensure that the air crew obtains sufficient rest during crew rest periods, including approval of extensions to the maximum air crew duty period.

6. Sterile Cockpit Rules

   a. The "Sterile Cockpit" concept recognizes that flight operations other than routine cruise flight are intrinsically more hazardous and require the undivided and vigilant attention of all crewmembers. Non-essential conversations and activities not directly related to the operation of the aircraft and its mission are inappropriate.

   b. The Pilot in Command (PIC) is responsible to ensure that these non-essential conversations, activities, and otherwise distracting actions do not occur during those portions of the flight that are considered critical. Examples of critical portions of flight would be preparation, takeoff, climb and departure, operating in the search area, and arrival, descent and landing. Situations when other manned or unmanned aircraft are operating in the vicinity would also be considered critical.

   c. The simplest way to ensure that all crewmembers and passengers are aware of this requirement is to conduct a crew and passenger briefing prior to assembling the aircraft or prior to motor start. The Sterile Cockpit brief can be as simple as a general statement by the PIC indicating that an announcement will be made when the flight is in a critical phase of flight, or possibly, a detailed briefing of the various phases of flight that are considered busiest and critical for the crewmembers to avoid distractions.

   d. It is essential that the PIC include in the Sterile Cockpit brief a statement that safety of flight items are always appropriate to be brought to the immediate attention of the PIC. Safety concerns would be such items as potentially conflicting traffic, or potential mechanical problems with the aircraft (i.e., electrical smoke, erratic flight or nearby obstacles).

7. The Mission Pilot needs to know what goes into the CAPF 109U, sUAS Sortie Flight Summary, in order to help inexperienced technicians and to be able to maintain the form if the technician is otherwise occupied. The form is a maintained from take-off until landing, and should include all events and sightings. As this information is entered into WMIRS it will be reviewed by the incident commander and general staff after the debriefing and becomes a part of the total information that is the basis for subsequent actions and reports. Good logs give the staff a better picture of how the mission is progressing. If sketches or maps are made to compliment a sighting, note this and attach them to the log. Maps, photos, and sketches should be uploaded into WMIRS.

8. Ensure that the micro SD memory card that contains any imagery from a sortie is securely bagged and identified. Record a chain of custody on the CAPF 109U when you pass the memory card to another person who will be responsible for the card's safekeeping.

Additional Information

More detailed information on this topic is available in CAPR 70-1U and CAPP 70-1U.

Evaluation Preparation

Setup: Provide the student with a current copy of CAPR 70-1U and CAPP 70-1U.

Brief Student: You are a sUAS Mission Pilot trainee asked about your duties and responsibilities, and to discuss the sUAS Sortie Flight Summary form.

Evaluation

Performance measures:	Results	
1. State the first and foremost duty of the mission pilot.	P	F
2. State the second-most important duty of the mission pilot.	P	F
3. Discuss general duties and responsibilities.	P	F
4. Discuss the sterile cockpit rules.	P	F
5. Discuss the information recorded on the CAPF 109U.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5101

Discuss General UAS Related Safety & ORM Requirements and Issues

CONDITIONS

You are a UAS Mission Pilot or Technician trainee and must understand and demonstrate how to conduct an Operational Risk Analysis for your UAS flight operations.

OBJECTIVES

Understanding and expertise using the ORM Matrix as an aid to decision making when flying UAS missions.

TRAINING AND EVALUATION

Training Outline.

1. The ORM matrix provides an easy way to consider the primary issues when engaged in aeronautical decision making. The risk matrix form header contains identifying information for the PIC, mission, and flight release authority.

2. The ORM Matrix focuses on four elements of risk and potential hazards in UAS flight.

CIVIL AIR PATROL
SMALL UNMANNED AERIAL SYSTEMS
OPERATIONAL RISK MANAGEMENT MATRIX

MISSION NUMBER		SORTIE		DATE	
sUAS PILOT IN COMMAND		CAPID		INITIALS	
AIR OPERATIONS BRANCH DIRE		CAPID		INITIALS	

HAZARD IDENTIFICATION	LOW	PTS	MODERATE	PTS	HIGH	PTS
TEAM						
COA REQUIRED	NONE	0	NIGHT / BLVOS	2	VER PEOPLE / DROPPING OE	3
PILOT PIC EXPERIENCE	50 HOURS OR MORE	0	20-50 HOURS	1	20 HOURS OR LESS	2
TEAM SIZE	3 OR MORE MEMBERS	0	2 MEMBERS (UASMP / UAST)	1	1 MEMBER	N/G
TEAM REST	RESTED	1	SOME FATIGUE	2	TIRED	N/G
TEAM EXPERIENCE	75%-100% QUALIFIED	1	50%-74% QUALIFIED	2	UNDER 50% QUALIFIED	3
PIC FLIGHT CURRENCY	>1 HOUR IN LAST QTR	0	0.1 TO 1.0	2	< 0.1 HOUR IN LAST QTR	3
REFLECTIVE VEST	ALL OUTFITTED	0			ALL NOT OUTFITTED	N/G

3. When considering risk associated with the team, you will assign Low, Moderate, or High risk to each of the Team's potential hazards. These include whether or not a COA is required from the FAA, the level of Pilot experience, the size of the Team, the amount of team rest in their duty day, the level of team experience and qualifications, the PIC's UAS flight currency, and whether or not reflective garments are being worn. Based on your selections in each of these categories a number of points from 0-3 is assigned based on the level of risk (low, medium, high). If the category option says "N/G" that means "No Go" and the flight cannot be conducted.

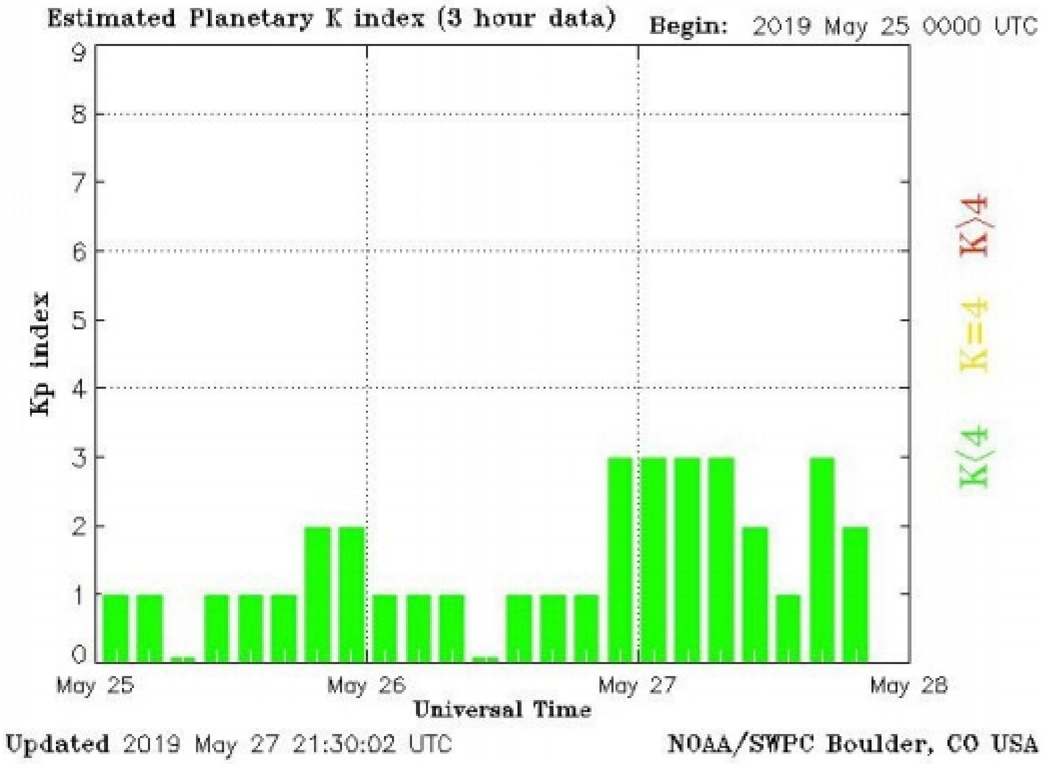
4. You will continue with the next category of hazard and risk which is the Machine. First you will identify the type and complexity of the UAS to be flown. Next you will identify any maintenance issues or risks. Finally, you will identify the communications tools you have available to support your flight. Having better communications tools can reduce risk.

5. The next category of hazard and risk is the Environment. This includes the temperature, the visibility, whether or not there is precipitation, the K-p index, and the terrain over which you are flying. You will assess the level of risk by selecting the criteria for each environmental element.

MACHINE						
sUAS TYPE	SIMPLE (GPS MODES)	1	SIMPLE (ATTI MODES)	2	COMPLEX	3
MAINTENANCE	NO KNOWN PROBLEMS	1	DUE FOR MAINTENACE	2	CANNOT PASS PREFLIGHT	N/G
COMMUNICATIONS	VHF MOBILE & CELL PHONE	1	HANDHELD VHF OR CELL	2	NO RADIO OR CELL PHONE	N/G
ENVIRONMENT						
TEMPERATURE	BETWEEN 45 AND 80	1	UNDER 45, OVER 80	2	UNDER 20, OVER 95	3
VISIBILITY	OVER 3 SM	0	LESS THAN 3 SM (W/ COA)	2	LESS THAN 1 MILE	N/G
PRECIPITATION	NONE	0	RAIN/FOG	2	HEAVY RAIN, SLEET/SNOW	3
KP INDEX	1 TO 3	1	3 TO 6	2	7 OR MORE	N/G
TERRAIN	FLAT OR LOW HILLS	1	LARGE HILLS, SMALL MOUNTAINS	2	LARGE MOUNTAINS, CLIFFS	3

6. The K-p index relates to electromagnetic interference. Higher indexes pose higher risks for the communications and control links necessary to safe UAS navigation. You can find the K-p index by visiting the NOAA website before your UAS flight.

PLANETARY K-INDEX



7. The final category of hazards and risks is the Mission itself. For each of the criteria you will assess a level of risk, starting with the number of UAS teams in the area of responsibility (AOR), the number of aircraft in the AOR with coordination, the travel time to get to the UAS launch site, and the traffic conditions the team will encounter travelling to the site. All of these conditions could affect the success of the flight and its mission.

MISSION						
COMPLEXITY	SIMPLE TASKS, NO NEW TECHNOLOGY	1	COMPLEX TASKS, NO NEW TECHNOLOGY	2	COMPLEX TASKS, NEW TECHNOLOGY	3
# OF SUAS TEAMS IN AOR	1-2 TEAMS	1	3-4 TEAMS	2	OVER 5 TEAMS	3
AIRCRAFT IN AOR	NO AIRCRAFT IN AOR	1	AIRCRAFT IN AOR W/ COORD	2	IRCRAFT IN AOR W/O COOR	3
TRAVEL ESTIMATE TO SITE	50 MILES OR LESS	1	51-100 MILES	2	OVER 100 MILES	3
TRAFFIC TO SITE	HT TO NONE (RURAL / AIR TR	1	MODERATE (CITY)	2	HEAVY (RUSH HOUR)	3
TOTALS		11		5		
FINAL ORM SCORE	16					

A "N/G" score in any of the ORM factors means no sortie is authorized under these conditions. The composition and conditions associated with the sortie must be changed, causing a change of the ORM score to within an appropriate risk scenario, prior to releasing a sortie.

OVERALL RISK ASSESSMENT	SIGNATURE	DATE
LOW RISK = 14-27, BRIEFING OFFICER APPROVAL		
MODERATE RISK = 28-37, AOBD/OSC APPROVAL		
HIGH RISK = 38-49, WING/CC, DO, DOU, OR IC APR		

This form must be completed prior to launch. If the sortie is launched remotely, the Final ORM Score must be given to the briefing officer so that a phone approval may be granted. In the event of a phone approval the form must be forwarded to the appropriate party for signature after action.

CAPF 62U OPR: DOU

8. Once you have selected the level of risk in each category, you tabulate the total values in the low, medium, and high column and add them together to get the final ORM score. In the illustrated example the score is 16. Then you look at the three ranges of scores for low risk (14-27), moderate risk (28-37), and high risk (38-49) to determine the level of flight release authority, which is required for your mission. Higher levels of risk require higher levels of authority to release the flight. The approving authority 's signature becomes a permanent part of the overall risk assessment and is retained as part of the mission file.

9. UAS flight releases are accomplished by sortie, not individual UAS flights. A sortie is typically related to the duty day and may contain multiple flights by multiple pilots and teams. The ORM process provides a consistent way for Civil Air Patrol UAS pilots and aircrews to assess risk and maintain safety consciousness.

Additional Information

More detailed information on this topic will be provided in the future.

Evaluation Preparation

Setup: Provide the trainee with an Operational Risk Management Matrix form. (see Section 0 of notebook).

Brief Student: You are a UAS Mission Pilot or Technician trainee asked to assess the mission hazards and risks.

Evaluation

<u>Performance measures</u>: <u>Results</u>

1. Complete the top identifying section of your ORM Matrix form P F

2. For each of the following categories, select the risk level associated with your proposed flight in each sub- category: P F

  a. Team
  b. Machine
  c. Environment
  d. Mission

3. Total up your overall ORM score and identify the level of approving authority required for your release. P F

Trainee must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5102

<u>Demonstrate knowledge of the risk and risk mitigation associated with flying UAS aircraft</u>

CONDITIONS

You are a UAS Mission Pilot trainee and must understand and demonstrate how to identify potential hazards, assess their level of risk, and design or establish controls that will enable you to mitigate risk to an acceptable level for your UAS flight operations

OBJECTIVES

Understanding and expertise using the DD Form 2977 Deliberate Risk Assessment Worksheet as an aid to aeronautical decision making when flying UAS missions.

TRAINING AND EVALUATION

Training Outline

1. The Deliberate Risk Assessment Worksheet (DRA) leads a PIC through a systematic process of identifying potential failure points in UAS flight operations, assigns a level of risk to them, for each of them list actions or controls that will reduce risk, and finish up by identifying who is responsible and what they need to do. At the conclusion of the use of the worksheet the UAS Mission Pilot will have created a plan to mitigate risks to an acceptable level in order to get approval from higher authority. The DRA complements the ORM Matrix because the ORM Matrix identifies overall levels of risk associated with an activity. The DRA takes that initial level of risk as a starting point and identifies mitigation that can further reduce risks to an acceptable level. It is “deliberate ” because it takes risk analysis one step farther to risk mitigation.

2. The first section of the DRA Worksheet contains identifying and contact information and the signature of the preparer.

DELIBERATE RISK ASSESSMENT WORKSHEET				
1. MISSION/TASK DESCRIPTION Camp Smith Training Site - Civil Air Patrol UAS Training Activity - 1-2 June 2019				**2. DATE** *(DD/MM/YYYY)* 28 May 2019
3. PREPARED BY				
a. Name (Last, First Middle Initial) VREELAND, Thomas S.			**b. Rank/Grade** Lt Col	**c. Duty Title/Position** UAS Program Manager, NY Wing, CAP
d. Unit NY Wing CAP (NY-001)	**e. Work Email** tvreeland@taconic.net		**f. Telephone** *(DSN/Commercial (Include Area Code))* 518 620 6380	
g. UIC/CIN *(as required)* UAS MPAS	**h. Training Support/Lesson Plan or OPORD** *(as required)*		**i. Signature of Preparer** Thomas S. Vreeland Digitally signed by Thomas S. Vreeland Date: 2019.05.27 18:54:33 -04'00'	
Five steps of Risk Management: (1) Identify the hazards (2) Assess the hazards (3) Develop controls & make decisions (4) Implement controls (5) Supervise and evaluate *(Step numbers not equal to numbered items on form)*				

3. The process of assigning initial and final levels of risk is based on the following Risk Assessment Matrix. This matrix has two dimensions, Probability (how likely an event will happen), and Severity (how serious the consequences will be). By selecting a severity level and assigning a probability to it for each hazard, you can come up with a risk level of Low, Medium, High, and Extremely High. These risk levels will be identified for each hazard, before and after any mitigation efforts.

Risk Assessment Matrix		**Probability** *(expected frequency)*				
		Frequent: Continuous, regular, or inevitable occurrences	**Likely:** Several or numerous occurrences	**Occasional:** Sporadic or intermittent occurrences	**Seldom:** Infrequent occurrences	**Unlikely:** Possible occurrences but improbable
Severity *(expected consequence)*		**A**	**B**	**C**	**D**	**E**
Catastrophic: *Mission failure, unit readiness eliminated; death, unacceptable loss or damage*	**I**	**EH**	**EH**	**H**	**H**	**M**
Critical: *Significantly degraded unit readiness or mission capability; severe injury, illness, loss or damage*	**II**	**EH**	**H**	**H**	**M**	**L**
Moderate: *Somewhat degraded unit readiness or mission capability; minor injury, illness, loss, or damage*	**III**	**H**	**M**	**M**	**L**	**L**
Negligible: *Little or no impact to unit readiness or mission capability; minimal injury, loss, or damage*	**IV**	**M**	**L**	**L**	**L**	**L**
Legend: **EH -** Extremely High Risk **H -** High Risk **M -** Medium Risk **L -** Low Risk						

4. The first category of potential hazard identified in this DRA is “Takeoff and Landing Mishaps”. Within this category there are two hazards identified: “Operator Error” and “Automatic Takeoff and Landing System Errors”. For each hazard an initial risk level is shown. In column 7, Controls are listed that could mitigate each of the

hazards. Column 8 answers the question “How will the mitigation be implemented?” and “Who will implement it?”. The final column shows the residual risk level after implementation of the mitigation.

	4. SUBTASK/SUBSTEP OF MISSION/TASK	5. HAZARD	6. INITIAL RISK LEVEL	7. CONTROL	8. HOW TO IMPLEMENT/ WHO WILL IMPLEMENT	9. RESIDUAL RISK LEVEL
	Takeoff and/or Landing Mishaps	Operator Error	L	1. Training - Currency 2. Duty Day Limits 3. Pilot pairing 4. Sortie ORM	How: Follow SOP and sterile cockpit procedures and assess ORM before flight Who: Pilot in Command	L
		Automatic Takeoff/ Landing System Failure	L	1. Practice pilot change of control procedures 2. Preflight inspection	How: Execute pre-sortie and preflight checklists Who: Pilot in Command and Visual Observer	L

5. The next category of risk is “Loss of control ” of the UAS. Two specific hazards are identified: “Loss of UAV power” and “Loss of heading, altitude, or position (GCS link)”. Both have a low initial risk assessment. Both can be further mitigated to reduce risk and the specific action steps and who is responsible are indicated.

	4. SUBTASK/SUBSTEP OF MISSION/TASK	5. HAZARD	6. INITIAL RISK LEVEL	7. CONTROL	8. HOW TO IMPLEMENT/ WHO WILL IMPLEMENT	9. RESIDUAL RISK LEVEL
	Loss of Control	Loss of UAV power	L	1. Preflight inspection, battery test, and log book 2. Land with 20% battery power available	How: Follow battery inspection and use SOP Who: Pilot in Command and Visual Observer	L
		Loss of heading, altitude, or position (GCS link)	L	1. Check and Set RTH parameters before flight 2. Maintain secure flying field 3. Invoke RTH procedure	How: Preflight Inspection of airframe and software set-tings - Airfield security Who: Pilot in Command Safety Officer	L

6. The next category of risk is “Controlled flight into the ground”. In this case, two specific hazards are identified: “Mission Planning or Operator Error ”, “Loss of Return to Home (RTH) function” and “Loss of heading, altitude, or position (GCS link)”. Both have a low initial risk assessment. Both can be further mitigated to reduce risk and the specific action steps and who is responsible are indicated.

+ -	Controlled Flight into Ground	Mission Planning or Operator Error - Failure to See and Avoid terrain	L	1. Aircrew Duty Day Limits 2. Training and currency 3. Maintain VLOS 4. Positioning of added Observers	How: Preflight planning and execution Proper aircrew assignments for flying field Who: Pilot in Command	L
+ -		Loss of Return to Home function	L	1. Preflight inspection 2. Battery management and testing 3) Monitor K-index and electromagnetic environment 4) Check satellite lock and number	How: Perform preflight inspection and battery mgmt. Prepare to assume control Who: Pilot in Command UAS Technician	L

7. The next category of risk is “Mid Air Collision” of the UAS. Two specific hazards are identified: “Mission Planning or Operator/Observer VLOS Error ” and “Failure to yield right of way to other aircraft”. Both have a low initial risk assessment. Both can be further mitigated to reduce risk and the specific action steps and who is responsible are indicated.

+ -	Mid Air Collision	Mission Planning or Operator/Observer VLOS Error	L	1. Maintain VLOS 2. Anticipate visibility issues 3. Traffic Training 4. Monitor a/c frequencies 5. Coordinate traffic 6. Provide right of way	How: Follow checklists and SOP for high traffic environments Who: Pilot in Command Visual Observer	L
+ -		Failure to yield right of way to other aircraft	L	1. Maintain VLOS 2. Anticipate visibility issues 3. Traffic Training 4. Monitor a/c frequencies 5. Coordinate traffic 6. Provide right of way	How: Follow checklists and SOP for high traffic environments Who: Pilot in Command Visual Observer	L

8. The next category of risk is “Injury to Ground Crew” of the UAS. One hazard is identified: “Flight Line Hazards.” It has a low initial risk assessment. The next category of risk is “Injury to others on ground or property

damage”. Two specific hazards are identified: “Operator Error - Flight over people ” and “Flying field security failure ”. These hazards have Medium risk. Both can be further mitigated to reduce risk to “low ” and the specific action steps and who is responsible are indicated.

	4. SUBTASK/SUBSTEP OF MISSION/TASK	5. HAZARD	6. INITIAL RISK LEVEL	7. CONTROL	8. HOW TO IMPLEMENT/ WHO WILL IMPLEMENT	9. RESIDUAL RISK LEVEL
+ -	Injury to Ground Crew	Flight Line Hazards	L	1. Maintain Sterile Cockpit at Flight Line 2. Training 3. Monitor for hazards	How: Follow preflight SOP and checklists Place GCS down before approaching UAS Who: Pilot in Command UAS Technician	L
+ -	Injury to others on ground or damage to property	Operator Error - Flight over People	M	1. Training and currency 2. Adequate number of Visual Observers and security personnel 3. Prepare to hand over control and follow emergency procedures 4. Maintain CRM, duty day, and physiological standards	How: Follow SOP and practice emergency situations Who: Pilot in Command and entire aircrew	L
+ -		Flying Field Security Failure	M	1. Training and currency 2. Adequate number of Visual Observers and security personnel 3. Prepare to hand over control and follow emergency procedures 4. Maintain CRM, duty day, and physiological standards	How: Follow SOP and practice emergency situations Maintain a secure perimeter Who: Pilot in Command OIC - Security team	L

9. In the final category the risk is “UAS Loss”. Four specific hazards are identified: “Invalid Mission Plan or parameters”, “Operator Error - Fatigue”, “Control of multiple UAS”, and “Failure to maintain sterile cockpit”. All four have a low initial risk assessment. They all can be further mitigated to reduce risk and the specific action steps and who is responsible are indicated.

	4. SUBTASK/SUBSTEP OF MISSION/TASK	5. HAZARD	6. INITIAL RISK LEVEL	7. CONTROL	8. HOW TO IMPLEMENT/ WHO WILL IMPLEMENT	9. RESIDUAL RISK LEVEL
+ -	UAS Loss	Invalid Mission Plan or parameters	L	1. Training and currency 2. Follow pre-sortie and preflight checklists 3. Test fly your mission plan on simulator	How: Validate and test plan Follow Autonomous flight checklist Who: Pilot in Command	L
+ -		Operator Error - Fatigue	L	1. Perform self assessment before flying 2. Meet duty day and rest standards 3. Be a team. Watch your teammates	How: Follow duty SOP and take care of health and well being Who: Pilot in Command and entire aircrew	L
+ -		Control of multiple UAS	L	1. Limit multiple UAS operations to experienced personnel 2. Have a plan to coordinate multiple UAS flights 3. Use extra Visual Observers 4. Maintain Sterile Cockpit	How: Follow SOP and checklists Maintain VLOS and monitor traffic Who: Pilot in Command Visual Observer	L
+ -		Failure to maintain sterile cockpit	L	1. Maintain Sterile Cockpit 2. Limit multiple UAS operations to experienced personnel 3. Have a plan to coordinate multiple UAS flights	How: Follow SOP and checklists Maintain VLOS and monitor traffic Who: Pilot in Command Visual Observer	L

10. The final section of the DRA Worksheet contains an overall residual risk level after all controls have been implemented. It also contains a narrative supervisory plan and recommended courses of action, along with an approval or disapproval by the appropriate command authority.

10. OVERALL RESIDUAL RISK LEVEL *(All controls implemented)*:			
☐ EXTREMELY HIGH	☐ HIGH	☐ MEDIUM	☒ LOW

11. OVERALL SUPERVISION PLAN AND RECOMMENDED COURSE OF ACTION

An extensive Operational Risk Management methodology is utilized by Civil Air Patrol for all of our UAS flight operations. Every UAS Pilot and aircrew member completes a risk assessment before each sortie. All UAS flights at CSTS will be conducted in accordance with FAA Part 107 regulations, be conducted and managed by FAA Certified Part 107 Remote Pilots, and will be monitored by a CAP UAS Safety Officer. On the dates for this activity all flights will be contained within the Parade Field area at altitudes up to 200' AGL. Up to two flights may be conducted concurrently with proper spatial and temporal separation.

12. APPROVAL OR DISAPPROVAL OF MISSION OR TASK ☒ Approve ☐ Disapprove

a. Name (Last, First, Middle Initial)	b. Rank/Grade	c. Duty Title/Position	d. Signature of Approval Authority
VREELAND, Thomas S.	Lt Col	Wing UAS Program Manager	Thomas S. Vreeland Digitally signed by Thomas S. Vreeland Date: 2019.05.28 10:01:03 -04'00'

e. Additional Guidance:

Additional Information

More detailed information on this topic will be provided at a later time.

Evaluation Preparation

Setup: Provide the student with a blank copy of a DD 2977 DRA Worksheet.

Brief Student: You are a UAS Mission Pilot trainee asked about mitigating risks.

Evaluation

Performance measures:	Results	
1. Start a DRA Worksheet for a mission sortie.	P	F
2. Identify at least 3 categories of failure or risk with initial risk levels.	P	F
3. Associate at least 2 hazards with each category.	P	F
4. Concerning each hazard, identify controls that if implemented would reduce risk.	P	F
5. Specify responsibility for implementing the controls and what they do.	P	F
6. Determine residual risk level for each hazard.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5103

Discuss Type of Flights Performed by CAP UAS Aircrews

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must discuss the types of flights performed by CAP aircrews.

OBJECTIVES

Discuss the types of flights performed by CAP UAS aircrews.

TRAINING AND EVALUATION

Training Outline

1. As a UAS Mission Pilot trainee, knowing the types of flights that CAP UAS aircrews perform is essential. CAPR 70-1U covers the types of flights for CAP unmanned aircraft, but we want to look at a few of these in a little more detail. Note that per CAPR 70-1U, and FAA Part 107, the minimum flight visibility for UAS flight in Class G airspace is three statute miles.

2. **Search and Rescue flights.** Search and rescue flights, including route searches, and DF searches, grid searches, terrain based searches and expanding box searches, as well as searches of points of interest fall into this category.

3. **UAS Orientation flights.** UAS demonstration flights, UAS flight clinics, and UAS Orientation flights for senior members and cadets fall into this category. Depending on the UAS type used these flights may be regulated under Section 349 or under Part 107 of the FARs.

4. **Disaster Relief - Damage Assessment flights.** Under DSCA authority the US military, or Homeland Security Department, or FEMA, may request CAP UAS Teams to participate in disaster relief missions and to do damage assessment in the aftermath of disasters.

5. **Airborne Photography.** More and more, we are performing aerial reconnaissance and photography for national agencies. Emergency response planners expect more timely information about developing situations, and they recognize that aerial photos or video are an invaluable tool. We primarily take still photos (primarily digital), and the mission pilot must know how to fly airborne photo flight patterns. As SAR missions decline and the phase-out of 121.5 MHz ELTs begins, imaging will become one of CAP's most valuable assets.

   Emergency response planners expect more timely information about developing situations. These planners recognize real-time and near real-time images as an invaluable tool. The value of imagery is vastly increased if it is appropriately geotagged and identified with useful metadata.

   The key to a successful imaging mission is preparation, planning, patience and practice! UAS Mission Pilots need to practice flying imaging patterns with image sensors in order to master the patterns and the communications necessary to get the best images.

6. **Proficiency Flights.** CAPR 70-1U encourages UAS pilots to maintain currency and proficiency by accomplishing a self- conducted proficiency flight at least once every 90 days (Self Conducted Pilot Proficiency Flight Guidelines). Watch for updates regarding UAS flights.

Adhere to the restrictions in CAPR 70-1U when practicing in-flight emergencies.

As the demands on the CAP UAS mission pilot increase, the need to maintain and improve your mission skills becomes more important. Besides the guidance given in the sUASMP Proficiency Profiles, you should also practice:

a. Search patterns. Use the appropriate mission planning app as your primary tool but also practice planning and flying the different patterns using waypoints and pilotage.
b. Proficiency. Practice UAS maneuvers, emergency procedures, and sensor operations as often as possible.

7. **Counter-UAS mission.** The Counter-UAS missions are new to Civil Air Patrol in 2019. The USAF requested CAP support for the training of Air Force Base Force Protection personnel in the detection, identification, tracking, and mitigation of UAS that intrude on base airspace or overfly critical infrastructure. The Air Force wanted Red Team "Aggressor" forces whose UAS would intrude on military bases to train defenders in their response. CA responded to the call and is standing up Counter-UAS teams in 15 Wings.

Additional Information

More detailed information on this topic is available in CAPR 70-1U and in Chapter 9 of the MART Vol. II, *Mission Observer/SAR-DR Mission Pilot* Reference Text.

Evaluation Preparation

Setup: Provide the student with a current copy of CAPR 70-1U and the MART Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text.

Brief Student: You are a Mission Pilot/Technician trainee asked about the types of CAP flights.

Evaluation

Performance measures:	Results	
Concerning types of CAP flights, discuss:	P	F
a. Search and Rescue.		
b. Orientation.		
c. Disaster Relief and Damage Assessment.		
d. Aerial photography, including the typical flight profile,		
e. Proficiency Flying.		
f. Counter-UAS Missions		

Trainee must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5104

Discuss UAS Security Concerns and Procedures

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must discuss security concerns and restrictions.

OBJECTIVES

Discuss security concerns and restrictions.

TRAINING AND EVALUATION

Training Outline

1. As a Mission Pilot trainee, knowing security concerns and restrictions is essential.

2. **Security Concerns.** CAP resources should be considered National Security assets. In times of emergency you should take special security precautions to protect your aircraft and its crew. Some examples are:

   Aircraft and Equipment
   a. Keep your UAS and UIF in a locked and secure area. Use seals on equipment cases to detect tampering.
   b. Pay particular attention during UAS pre-flight inspections. Look for signs of tampering and carefully inspect the aircraft, Control Station, and batteries for damage.

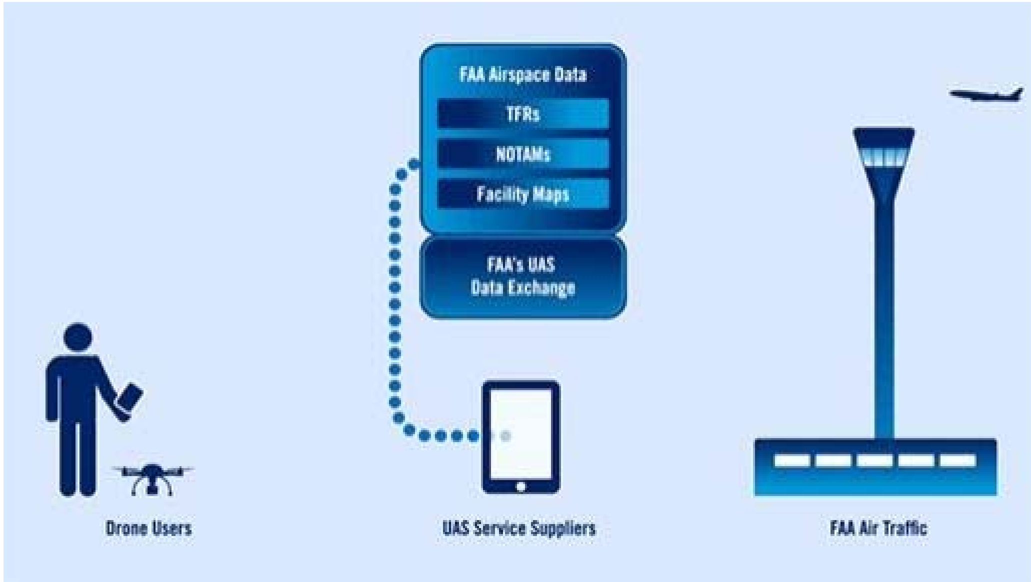
   Ground and Crews
   a. Be as "low key" as possible, and be discrete. Don't discuss CAP business, or UAS missions, in public places.
   b. Be aware of your surroundings at all times. If you see something or someone that is suspicious, don't ignore it. Report your suspicions to your supervisor and/or law enforcement.
   c. Wear safety vests and identifying placards when flying a UAS in public spaces.
   d. Be prepared to identify yourself to local authorities and present your credentials.

3. **Airspace restrictions.** The FAA may issue Temporary Flight Restrictions at any time, so it is vitally important to ask for FDC NOTAMs before each flight and to monitor ATC for changes while in flight. TFRs were issued to establish enhanced Class B airspace, protect airspace around nuclear facilities, and protect airspace around large gatherings of people. You can find them here: https://www.faa.gov/pilots/safety/notams_tfr/

4. **LAANC.** LAANC is the Low Altitude Authorization and Notification Capability, a collaboration between FAA and Industry. It directly supports UAS integration into the airspace. It provides access to controlled airspace near airports through near real-time processing of airspace authorizations below approved altitudes in controlled airspace.

   LAANC automates the application and approval process for airspace authorizations. Through automated applications developed by an FAA Approved UAS Service Suppliers (USS) pilots apply for an airspace authorization. Requests are checked against multiple airspace data sources in the FAA UAS Data Exchange such as temporary flight restrictions, NOTAMs and the UAS Facility Maps. If approved, pilots receive their authorization in near-real time.

   Who can use LAANC? Drone pilots operating under the Small UAS Rule Part 107 wanting to fly in controlled airspace around airports.



Additional Information

More detailed information on this topic is available in CAPR 70-1U.

Evaluation Preparation

Setup: Provide the student with a current copy of CAPR 70-1U.

Brief Student: You are a Mission Pilot/Technician trainee asked security concerns and restrictions, and your actions if dealing with them.

Evaluation

Performance measures:	Results	
1. Discuss security concerns, in the air and on the ground.	P	F
2. Discuss airspace restrictions and LAANC.	P	F
3. Describe how you can find and identify TFRs and flight restrictions.	P	F

Trainee must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5105

Demonstrate How to Keep Camera, Accessories and GPS System Mission Ready

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must demonstrate how to keep the camera, accessories, and GPS systems mission ready.

OBJECTIVES

Discuss UAS camera function, operations, and maintenance concerns.

TRAINING AND EVALUATION

Training Outline

Camera

Profile

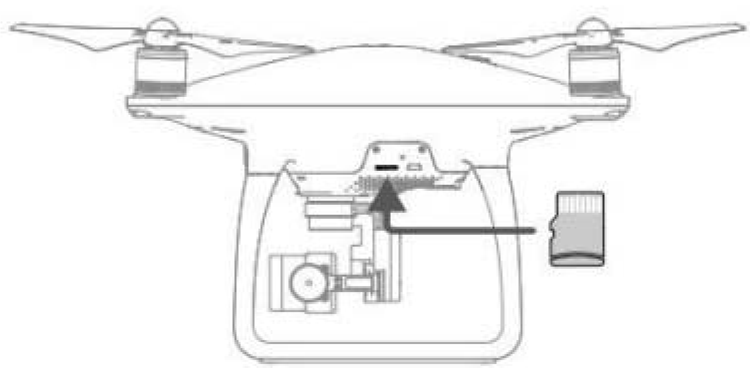
The Phantom 4 Pro / Pro+ camera uses 1-inch CMOS sensor to capture video (up to 4096×2160p at 60fps) and 20 megapixel stills. Videos can be stored in either MOV or MP4 formats. Available picture shooting modes include burst, continuous, and time-lapse mode. A live preview of what the camera sees can be monitored on the connected mobile device via the DJI GO 4 app.

The Phantom 4 Pro / Pro+ supports the capture of 4K at 60fps. Both H.265 and H.264 are supported, with a maximum video bitrate of 100 Mbps.

The 20 megapixel photos taken by Phantom 4 Pro / Pro+ is the result of the application of advanced image processing technique. A variety of shooting modes deliver a better shooting experience. A mechanical shutter with a 1/2000 max speed eliminates rolling shutter distortion when capturing stills of fast moving objects.

Camera Micro SD Card Slot

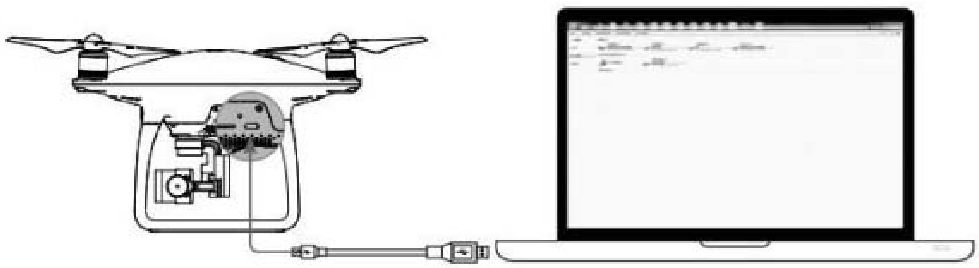
To store your photos and videos, insert the Micro SD card into the slot as shown below before turning on the Phantom 4 Pro / Pro+. The Phantom 4 Pro / Pro+ comes with a 16 GB Micro SD card and supports Micro SD cards up to 128 GB. A UHS-1 and above Micro SD card is recommended due to their fast read and write speeds that support high-resolution video data.



1. The Camera Sensor on a DJI Phantom 4 Pro UAS is a high quality camera capable of capturing high resolution 20 Mp still images and 4K 60fps video. It is a key component of the UAS.

2. The camera stores images and video on a 16Gb memory card, that can be expanded up to 128 Gb of storage. Managing space and files on the Memory card is one of the most important responsibilities of the UAS Technician. Images from the Memory card can be loaded onto a computer for post flight processing. Creating orthomosaic images from still images or video is one of the critical post flight workflows the UAS Technician manages.

3. In order to access the images stored on the Memory card using a USB connection between the aircraft and a computer, the aircraft must be powered up.



⚠ The aircraft must be turned on before attempting to access the files on the Micro SD card.

Camera Operation

Use the Shutter and Record buttons on the remote controller to shoot the photos or videos through the DJI GO 4 app.

The status of the camera can be identified by watching the status LED indicator lights.

Camera Status LED Indicator Descriptions

The Camera LED Indicator lights up after the flight battery is powered on. It provides information on the working status of the camera.

Camera LED Indicator		Camera status
G ······	Green Fast Blink	System is warming up
G —	Solid Green	The system is warmed up, the Micro SD card is inserted and working properly
G	Green Blink Once	Taking a single picture
G ×3······	Green Blink 3 Times	Taking 3 or 5 photos per shot
R ······	Slow Red Blink	Recording
R ······	Fast Red Blink	Micro SD card error
R R ×2······	Double Red Blink	Overheated Camera
R —	Solid Red	System error
G R ······	Green and Red Blink	Firmware Upgrading

4. The camera lens must be kept clean and clear of debris on takeoff and landing. Be sure to rotate the camera gimbal up before takeoff and again before landing. When packing or storing the UAS be sure to install the gimbal lock to minimize shocks to the delicate gimbal electronics.

Additional Information

For more detailed information on the DJI P4P Camera and for optical and electronic specifications please consult the DJI P4P User Manual.

Evaluation Preparation

Setup: Provide the student with a P4P with camera.

Brief Student: You are a sUAS Mission Pilot/Technician trainee asked about how to protect the camera on the UAS.

Evaluation

Performance measures:	Results	
1. Without powering up the UAS, identify the camera, gimbal, and lock.	P	F
2. Describe the meaning of the camera's LED status lights.	P	F
3. Remove and replace the camera Memory card.	P	F
4. Describe care, cleaning, and maintenance of camera.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-2028

Discuss Crew Resource Management

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must discuss the fundamentals of Crew Resource Management (CRM).

OBJECTIVES

Discuss the fundamentals of CRM.

TRAINING AND EVALUATION

Training Outline

1. As a sUAS Mission Pilot/Technician trainee, understanding the fundamentals of Crew Resource Management (CRM) is essential.

2. Situational awareness. Simply put, situational awareness (SA) is "knowing what is going on around you at all times." SA is not restricted to just pilots -- everyone must exhibit SA at all times. Each crewmember must have their SA at peak levels while flying because it takes everyone's awareness to keep the plane safe in flight. Scanners and observers have their own unique positions and functions that require full attention, so their SA is essential to the safe operation of any CAP flight.

   Examples of good SA attitudes are:
   - Good mental health, where each crewmember is clear and focused.
   - Good physical health. This includes fatigue, sickness, hydration, and stress factors.
   - Attentiveness: Keep your attention on the task at hand.
   - Inquisitiveness: Always asking questions, challenging ideas, and asking for input.

   Examples of SA skills:
   - Professional skills developed through training, practice and experience.
   - Personal skills such as good communications. This is necessary to effectively get your point across or receive valid input. Interpersonal skills such the basic courtesies factor greatly into how a crew will get along, and this will greatly impact crew effectiveness and performance.

   To help prevent a loss of SA, use the IMSAFE guidelines. This checklist was developed for the FAA as a quick memory guide for aviators to run through and make self-determination as to their fitness to fly. If a crewmember says yes to any of these, they really shouldn't fly.

   Symptoms of loss of SA vary, but a few are:
   - Fixation
   - Ambiguity
   - Complacency
   - Euphoria
   - Confusion
   - Distraction
   - Overload
   - Improper performance of tasks or procedures

Overcoming Loss of SA:

a. Pilots and aircrew must realize that you can't have complete SA all the time; the key is to have a plan to recover. When a crew loses SA it is critical to reduce workload and threats:
   - Suspend the mission. Stop doing complicated things. [Remember to "Aviate, Navigate and Communicate."]
   - Get away from the ground and other obstacles (e.g., climb to a safe altitude)
   - Establish a stable flight profile where you can safely analyze the situation

b. Use terms like "Knock it Off," "Time Out," "Abort" or "This is Stupid." Once terms like these are called, the pilot should terminate the task or maneuver, climb away from the ground if necessary, establish straight-and-level flight and then discuss the problem. [The term you use should be agreed upon before the flight.]

   Be aware that lack of individual respect can cause alienation, which is a serious barrier to communication (see next section) and can shatter teamwork. If an individual is insulted or ignored when making comments they will shut down and stop working with the crew. When this happens the aircrew must solicit input in order to pull the alienated crewmember back into the mission

c. Keep the cockpit sterile -- keep talk to the minimum necessary for safety, particularly during taxi, takeoff, departure, low-level flying, approach, and landing. This helps remove distractions and keep everyone focused on the important things.

3. Barriers to communication. Rank, gender, experience level, age, personality, and general attitudes can all cause barriers to communication. You may occasionally be hesitant to offer an idea for fear of looking foolish or inexperienced. You may also be tempted to disregard ideas that come from individuals that have a lower experience level. If you are committed to teamwork and good crew coordination, you must look through such emotions and try to constructively and sensitively adapt to each personality involved.

   You can deal best with personalities by continually showing personal and professional respect and courtesy to your teammates. Criticism will only serve to build yet another barrier to good communication. Nothing breaks down a team effort faster than hostility and resentment. Always offer opinions or ideas respectfully and constructively. Instead of telling the pilot, "You're wrong," tell him what you think is wrong, such as "I think that new frequency was 127.5, not 127.9."

   Stress can have a very significant, negative effect on cockpit communication. An individual's preoccupation with personal, family, or job-related problems distracts him or her from paying complete attention to mission tasks and communication, depending upon the level and source of stress. The flight itself, personalities of the individuals, distractions, flight conditions, and individual performance can all be sources of communication-limiting stress. When stress reaches very high levels, it becomes an effective barrier to communication and job performance. Many fliers and medical specialists advocate refraining from flying or other complex tasks until the stress is removed.

4. Task saturation. At times, crews or individual members may be confronted with too much information to manage, or too many tasks to accomplish in the available time. This condition is referred to as task saturation. This will most likely happen when a crewmember is confronted with a new or different situation such as an emergency, bad weather, or motion sickness. Preoccupation with the different situation may then lead to a condition of "tunnel vision," where the individual can lose track of many other important conditions. In an advanced state, comprehension is so far gone that partial or complete situational awareness is lost. When individuals are task saturated to this extent, communication and information flow usually ceases.

No crewmember should ever allow the work management situation to deteriorate to such an extent as to adversely affect the pilot's ability to continue to safely operate the aircraft. Many preventable accidents have resulted from crews' entire involvement in other areas or problems, while the airplane literally flew into the ground. If any crewmember suspects pilot task saturation to be the case, nonessential discussion should cease, and the crew as a whole should discontinue low-priority aspects of the job, and even return to the mission base if necessary.

5. Assignment and coordination of duties. Assignment of aircrew duties is based on CAPR 60-3. All flight-related duties are conducted under the supervision of the aircraft commander. Mission-related duties may also be conducted under the supervision of the aircraft commander, but a properly trained observer can also fill the role of mission commander. The key is that positive delegation of monitoring duties is as important as positive delegation of flying duties.

   As previously discussed, it is very important for each crewmember to know what they are supposed to be doing at all times and under all conditions. Aircraft safety duties vary with the start up, taxi, takeoff, departure, transit, approach and landing phases of flight. Mission duties are related to the mission objective, primarily to fly the aircraft safely and precisely (the pilot) and to assist effectively (technician).

   Close attention should be paid during the pilot's briefing. The pilot will establish flight-specific safety "bottom lines" at this time, such as emergency duties and division of responsibilities. Each individual must again clearly understand his specific assigned duties and responsibilities before launching the aircraft.

   Other phases of the flight also require that distractions be kept to a minimum. Recent air transport industry statistics show that 67% of airline accidents during a particular survey period happened during only 17% of the flight time -- the taxi, takeoff, departure, approach, and landing phases. The FAA has designated these phases of flight as critical, and has ruled that the cockpit environment must be free of extraneous activity and distractions during these phases to the maximum extent possible (the sterile cockpit).

Additional Information

More detailed information and figures on this topic are available in Chapter 11 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Brief Student: You are a Scanner trainee asked to discuss the fundamentals and strategies of CRM.

Evaluation

Performance measures:	Results	
1. Discuss the fundamentals and strategies of Crew Resource Management: a. Situational awareness b. Barriers to communication c. Task saturation	P	F
2. Discuss assignments and aircrew coordination.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-2014

<u>Discuss CAP Liability Coverage and Mishap Reporting</u>

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must discuss CAP liability coverage and mishap reporting.

OBJECTIVES

Discuss liability coverage provided to CAP personnel and mishap reporting.

TRAINING AND EVALUATION

Training Outline

1. As a UAS mission aircrew member there is a small chance that you may be involved in an accident during a mission. A basic knowledge of liability coverage provided to you, and its applicability and limitations, is essential.

2. Using the current CAPRs 70-1U and 900-5 discuss the following, including when the coverage applies and what is covered:
   a. Federal Employee Compensation Act (FECA).
   b. Federal Tort Claims Act (FTCA).
   c. CAP corporate insurance.

   CAP, along with the Air Force, provides liability coverage for the organization and members. The Air Force coverage applies when CAP is engaged in missions certified by CAP-USAF as an Air Force Assigned Mission (AFAM); CAP coverage applies when CAP is engaged in corporate activities or missions. The following is taken from CAPR 900-5, The CAP Insurance/Benefits Program.

   Federal Employee Compensation Act (FECA) coverage is provided for all Air Force Assigned Missions (AFAM) as defined in CAPR 60-1 and the USAF/CAP MOU. This is the Workmen's Compensation Program for federal workers. The coverage provides full medical benefits, plus death, burial and disability benefits.

   State and local missions are not covered by FECA; these missions are designated as CAP Corporate (C) missions IAW CAPR 70-1U and are covered by commercial insurance; if an injury or death occurs, this insurance provides a $10,000 death benefit and up to $6,000 medical expenses. Coverage is provided so long as proper CAP authority authorizes the mission and the PIC is licensed and certificated as required by Federal Aviation Regulations. This liability coverage also applies to member owned/furnished aircraft.

   It is vitally important that CAP members follow all rules and regulations during missions. This includes wearing the proper uniform and carrying the proper credentials. Not following the rules may make you ineligible for coverage under FECA, FTCA, and corporate insurance, and can result in a member being held personally responsible for the damages or medical expenses incurred as a result of a mishap.

3. It is extremely important to report all mishaps. There are lessons to be learned from each mishap which help identify trends and some mishaps, that may first appear to be minor, are found to be more severe upon further discovery. For this reason, all mishaps must be reported using the mishap management portions of the eServices Safety Management System.

Unit / Activity Commanders are responsible for ensuring an on-line mishap notification is accomplished within 48 hours of a mishap. The online mishap management database documents all mishaps and is an important legal document that must be completed correctly. Failure to complete an on-line mishap notification could result in the member being held personally responsible for damages or medical expenses incurred, and loss of government- or corporate-provided insurance benefits.

4. Using the current CAPR 62-2 (Mishap Reporting and Investigation), discuss what constitutes an accident and an incident, when they must be reported, and what information is needed.

Summary of CAP Insurance Coverage

	TYPE OF CAP ACTIVITY		
Member Category	**Air Force Authorized Missions AFAM A and B Type Missions**	**CAP Corporate Missions C Type Missions**	**Other CAP Activity Meetings, Encampments, etc.**
Cadets under 18	Federal Tort Claims Act (FTCA) Liability Coverage (Limited) *(See Note Below)*	CAP Accident Coverage to $8,000	CAP Accident Coverage to $8,000
		CAP Death Benefits - $10,000	CAP Death Benefits - $10,000
		CAP General Liability Insurance Except Aircraft, Vehicles, FTCA	CAP General Liability Insurance Except Aircraft, Vehicles, FTCA
Cadets over 18	Federal Tort Claims Act (FTCA) Liability Coverage (Limited)	CAP Accident Coverage to $8,000	CAP Accident Coverage to $8,000
		CAP Death Benefits - $10,000	CAP Death Benefits - $10,000
	Federal Employees Compensation Act (FECA) Coverage and Death Benefits	CAP General Liability Insurance Except Aircraft, Vehicles, FTCA	CAP General Liability Insurance Except Aircraft, Vehicles, FTCA
Senior Members	Federal Tort Claims Act (FTCA) Liability Coverage (Limited)	CAP Accident Coverage to $8,000	CAP Accident Coverage to $8,000
		CAP Death Benefits - $10,000	CAP Death Benefits - $10,000
	Federal Employees Compensation Act (FECA) Coverage and Death Benefits	CAP General Liability Insurance Except Aircraft, Vehicles, FTCA	CAP General Liability Insurance Except Aircraft, Vehicles, FTCA

NOTE: For cadets under the age of 18 who participate in AFAMs (including Orientation Flights) parents should assure that family insurance coverage is available to cover personal injury, medical expenses, and death benefits.

NOTE 2: Use CAP Form 80 to document requests for reimbursement of medical expenses, accident costs, and death benefits.

Additional Information

More detailed information on this topic is available in Chapter 1 of the MART Vol. I, Mission Scanner Reference Text, and the guidance provided for the CAP on-line Safety Management System mishap reporting.

Evaluation Preparation

Setup: Provide the student with current copies of CAPRs 900-5, 70-1U and 62-2 (with a copy of CAPF 78). Allow access to a computer so the trainee can show you where the on-line mishap reporting is done.

Brief Student: You are an aircrew member asked to discuss FECA, FTCA and CAP corporate coverage, reporting requirements in case of a mishap, and assessments that may be made for aircraft damage.

Evaluation

Performance Measures:	Results	
1. Discuss FECA, including what types of missions afford this coverage and what is covered.	P	F
2. Discuss FTCA, including what types of missions afford this coverage and what is covered.	P	F

3. Discuss CAP corporate insurance, including what types of missions afford this coverage and what is covered. P F

4. Discuss CAP mishap reporting, including what must be reported and how. P F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-2015

Enter Data into CAP Forms

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must enter data into a form.

OBJECTIVES

Accurately and legibly enter data into forms and show how to correct mistakes.

TRAINING AND EVALUATION

Training Outline

1. As a sUAS Mission Pilot/Technician trainee you must know how to enter data into forms and how to correct mistakes.

2. CAP and our partner agencies rely on accurate and complete paperwork. CAP strives to maintain a professional image and providing data that is legible is essential to this image.

3. Filling out forms and other paperwork is an essential part of any mission. Time and effort must be given to this part of the mission. Most mission forms are filled out electronically (WMIRS). However, it may be some time before the forms used in the CAP UAS program are available in WMIRS

4. Some general rules to follow (most apply to paper forms):

   a. It is important not to obliterate a mistake (i.e., a person should still be able to read the mistaken entry). To correct mistakes, draw a single line through the error, enter the correct data, and initial.

   b. Do not use of "liquid paper" when making corrections.

   c. Do not use signature labels or stamped signatures.

   d. Attachments (e.g., maps or sketches) should have your name, the date, aircraft 'N' number or FAA Registration number, mission, sortie, and flight numbers, and Hobbs time, or log time, on them so they can be tied to the CAP form if they become separated. Maps and sketches are normally uploaded into WMIRS.

   e. Do not leave blanks; enter N/A in the blank.

   f. Always have another crewmember review the form before submittal.

Additional Information

More detailed information on this topic is available in Chapter 1 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Setup: Provide the student with a current copy of CAPF 109, 99, 104 or access to a CAPF 104 in WMIRS.

Brief Student: You are a sUAS Mission Pilot/Technician trainee asked general rules for entering data into forms, marking attachments to forms, and correcting mistakes.

Evaluation

Performance Measures:	Results	
1. Show how to correct a mistake.	P	F
2. Show how to mark a map that you will upload to WMIRS or attach to a form.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5109

Discuss How Atmospheric and Lighting Conditions Affect Visual Search Effectiveness

CONDITIONS

You are a sUAS Mission Pilot/Technician trainee and must discuss how atmospheric and lighting conditions affect scanning effectiveness.

OBJECTIVES

Discuss how atmospheric and lighting conditions affect scanning effectiveness.

TRAINING AND EVALUATION

Training Outline

1. As a Mission Scanner trainee, knowing how atmospheric and lighting conditions effect scanning is essential. During daylight there are many factors that can affect the scanner's ability to spot traffic, hazards or the search target. The following table shows the (approximate) distance at which the scanner can sight various objects under average visibility conditions; factors that can alter these distances are discussed below.

Object	Distance
Person in life jacket (open water or moderate seas)	1/2 mile
Person in small life raft (open water or moderate seas)	3/4 mile
Person in open meadow within wooded area	1/2 mile or less
Crash in wooded area	1/2 mile
Crash on desert or open plain	2 miles
Person on desert or open plain	1 mile or less
Vehicle in open area	2 miles or less

During darkness, scanners make fewer fixations in their search patterns than during daylight because victims in distress are likely to use lights, fires, or flares to signal rescuers. Contrast between signal light and surrounding darkness eliminates the need for scanners to concentrate on making numerous eye fixations. An attentive UAS Technician or observer should be able to see a light, flare, or fire easily during night operations. Regardless of light conditions, a UAS Technician should always maintain a systematic scanning pattern with fixations every few seconds. Darkness merely lengthens the interval between fixations.

2. Atmospheric conditions. All aircrews hope for perfect visibility during a SAR mission, but this atmospheric condition rarely exists. The atmosphere (especially the lower atmosphere) may contain significant amounts of water vapor, dust, pollen, and other particles, and these items can block vision according to their density. Of course, the farther we try to see the more particles there are and the more difficult it is to sight the objective.

3. Position of the sun. Flying “into the sun,” soon after it rises in the morning or before it sets in the afternoon, poses visibility problems. No doubt you have had this experience while driving or riding as a crewmember in an automobile. Recall how difficult it is to distinguish colors and to detect smaller objects. Sunlight directly on your Control Station tablet can blind you and restrict visibility of telemetry data on the display. In that event the sun shield will not help.

4. Clouds and shadows. Shadows produced by clouds can reduce the effective scanning range. This is due to the high contrast between sunlit area and shadows. Our eyes have difficulty adjusting to such contrasts. The same

effect occurs in mountainous areas where bright sunlight causes the hills and mountains to cast dark shadows. Heavy cloud cover can "wash out" colors on the ground, making wreckage and colored clothes or signal devices harder to sight.

5. Terrain and ground cover. The more intensive search efforts occur over terrain that is either mountainous or covered with dense vegetation, or both. Mountainous area searches demand frequent variation in the scanning range. This you can visualize fairly easily; at one moment the mountain or hill places the surface within, say 200 feet of the aircraft. Upon flying past the mountain or hill the surface suddenly may be a half- mile away. Forested areas can reduce the effective scanning range dramatically. This is especially true during spring, summer, and fall when foliage is most pronounced. The situation doesn't change for the better in the winter where trees are of the evergreen types-pine, spruce, etc.-because the height of the trees plus their foliage masks the search objective very effectively. Frequently the only way for a scanner to actually spot an objective under such circumstance is to be looking down almost vertically. There are other signs to look for in such areas, but we will discuss them later.

6. Surface conditions. Here we are thinking of snow, primarily. Even a thin covering of new snow will change the contour, or shape, of a search objective. Also, the light-reflective quality of snow affects visual effectiveness. The net result is a need to bring the scanning range nearer to the aircraft.

7. Use of binoculars, cameras, and sunglasses. Binoculars rapidly bring on eye fatigue when used by an additional mission member who is not acting as a member of the flight crew, and may lead to disorientation and airsickness. Binoculars are not permitted to be used by the Mission Pilot or Technician during operation of the aircraft. They should only be used for brief periods to check sightings or for detailed viewing of an assessment area or target. Looking at a tablet or smartphone screen for extended periods can be equally as discomforting. Take breaks whenever possible.

   Sunglasses are an important tool for aircrew, reducing eye fatigue and glare: however, sunglasses do have some negative aspects. Looking at a tablet or smartphone screen with polarized lenses can result in a reduced retinal image. Also, color discrimination is reduced while wearing dark lenses. And, of course, if you are looking for a lost person wearing a blue jacket, don't wear sunglasses with "blue-blocking" lenses. Finally, no matter how cool it may look, don't wear sunglasses while flying in low visibility conditions (i.e., overcast and at dawn, dusk or night).

Additional Information

More detailed information on this topic is available in Chapter 5 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Brief Student: You are a UAS Technician trainee asked about how atmospheric and lighting conditions effect observation, scanning of telemetry, and UAS visibility.

Evaluation

<u>Performance Measures</u>:	<u>Results</u>	
1. Discuss how atmospheric and lighting conditions effect scanning effectiveness.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5110

Identify Visual Clues and Wreckage Patterns from FPV and Orthomosaic Imagery

CONDITIONS

You are a sUAS Mission Pilot trainee and must identify and discuss typical visual clues and wreckage patterns.

OBJECTIVES

Identify and discuss typical visual clues and wreckage patterns you may find on images, live video, or stored video files.

TRAINING AND EVALUATION

Training Outline

1. As a sUAS Mission Pilot trainee, knowing what to look for in the search area is essential. If you have not had much experience at "looking down" while flying, there are some surprises in store for you. Objects appear quite different when they are seen from above and at a greater distance than usual. Even if you are very familiar with the territory as seen from the surface, scanning it from the air will reveal features and objects that you had no idea where there.

2. Typical visual clues. Anything that appears to be out of the ordinary should be considered a clue to the location of the search objective. In addition to this piece of advice, the following are specific clues for which UAS Technicians should be looking in live video, images, and stored video files:

   Light colored or shiny objects - Virtually all aircraft have white or other light colors as part of their paint schemes. Some aircraft have polished aluminum surfaces that provide contrast with the usual ground surface features and will "flash" in bright sunlight. Aircraft windshields and windows also have a reflective quality about them: if the angle of the sun is just right, you will pick up momentary flashes with either your central or peripheral vision. A flash from any angle deserves further investigation.

   Smoke and fire - Sometimes aircraft catch fire when they crash. If conditions are right, the burning airplane may cause forest or grass fires. Survivors of a crash may build a fire to warm themselves or to signal search aircraft.

   Blackened areas - Fire causes blackened areas. You may have to check many such areas (see false clues), but finding the search objective will make the effort worthwhile.

   Broken tree branches - If an airplane goes down in a heavily wooded area, it will break tree branches and perhaps trees. The extent of this breakage will depend on the angle at which the trees were struck. The primary clue for the scanner, however, will be color. As you no doubt realize, the interior of a tree trunk or branch and the undersides of many types of leaves are light in color. This contrast between the light color and the darker foliage serves as a good clue.

   Local discoloration of foliage - Here we are talking about dead or dying leaves and needles of evergreen trees. A crash that is several days old may have discolored a small area in the forest canopy. This discoloration could be the result of either a small fire or broken tree branches.

Fresh bare earth - An aircraft striking the ground at any angle will disturb or "plow" the earth to some degree. An overflight within a day or so of the event should provide a clue for scanners. Because of its moisture content, fresh bare earth has a different color and texture than the surrounding, undisturbed earth.

Breaks in cultivated field patterns - Crop farmlands always display a pattern of some type, especially during the growing season. Any disruption of such a pattern should be investigated. A crop such as corn could mask the presence of small aircraft wreckage, but the pattern made by the crashing airplane may stand out as a break in uniformity.

Water and snow - Water and snow are not visual clues, but they often contain such clues. For example, when an aircraft goes down in water its fuel and probably some oil will rise to the water's surface making an "oil slick" discoloration. Other material in the aircraft may also discolor the water or float as debris. If the aircraft hasn't been under the water very long, air bubbles will disturb the surface. Snow readily shows clues. Any discoloration caused by fire, fuel or debris will be very evident.

Tracks and signals - Any line of apparent human tracks through snow, grass, or sand should be regarded as possibly those of survivors.

Birds and animals - Scavenger birds (such as vultures and crows), wolves, and bears may gather at or near a crash site. Vultures (or buzzards) sense the critical condition of an injured person and gather nearby to await the person's death. If you see these birds or animals in a group, search the area thoroughly.

False clues - Examples are campfires and other purposely set fires, oil slicks that may have been caused by spillage from ships; and trash piles or pits. Aircraft parts may not have been removed from other crash sites, although some of the aircraft parts may have been marked with a yellow "X" (you may not be able to see the mark until near the site because the paint has faded or worn off with age).

Survivors and Signals - If there are survivors and if they are capable of doing so, they will attempt to signal you. The type of signal the survivors use will depend on how much they know about the process and what type signaling devices are available to them.

Nighttime signals - For various reasons, nighttime air searches are very infrequent. Light signals of some type will be the only clue to the search objective location. A fire or perhaps a flashlight will be the survivor's means of signaling. On the other hand, a light signal need not be very bright: one survivor used the flint spark of his cigarette lighter as a signal and he was rescued.

3. Wreckage patterns. Frequently, there are signs near a crash site that the aircrew can use to locate the actual wreckage. The environment plays a major role in sighting the signs from the search aircraft. In crashes at sea, searchers may be unable to locate the crash site as rough seas can scatter wreckage or signs quickly. On land, the wreckage may be in dense foliage that can obscure it in a matter of days. By knowing signs to look for, the scanner can improve the effectiveness of each sortie. In general, don't expect to find anything that resembles an aircraft; most wrecks look like hastily discarded trash. However, certain patterns do result from the manner in which the accident occurred.

   The *hole in the ground* is caused from steep dives into the ground or from flying straight into steep hillsides or canyon walls. Wreckage is confined to a small circular area around a deep, high-walled, narrow crater. The structure may be completely demolished with parts of the wings and empennage near the edge of the crater. Vertical dives into heavily wooded terrain will sometimes cause very little damage to the surrounding foliage, and sometimes only a day or two is needed for the foliage to repair itself.

The *corkscrew* (auger) is caused from uncontrolled spins. Wreckage is considerably broken in a small area. There are curved ground scars around a shallow crater. One wing is more heavily damaged, and the fuselage is broken in several places with the tail forward in the direction of the spin. In wooded areas, damage to branches and foliage is considerable, but is confined to a small area.

Creaming (smear) is often caused from low-level "buzzing" or an attempted crash landing. The wreckage distribution is long and narrow with heavier components farthest away from the initial point of impact. The tail and wings remain fairly intact and sheared off close to the point of impact. Ground looping sometimes terminates the wreckage pattern with a sharp hook and may reverse the position of some wreckage components. Skipping is also quite common in open, flat terrain. In wooded areas, damage to the trees is considerable at the point of impact, but the wreckage travels among the trees beneath the foliage for a greater distance and may not be visible from the air.

The *four winds* result from mid-air collisions, explosion, or in-flight break up. Wreckage components are broken up and scattered over a wide area along the flight path. The impact areas are small but chances of sighting them are increased by the large number of them.

Hedge trimming is caused when an aircraft strikes a high mountain ridge or obstruction but continues on for a considerable distance before crashing. Trees or the obstruction are slightly damaged or the ground on the crest is lightly scarred. Some wreckage components may be dislodged; usually landing gear, external fuel tanks, cockpit canopy, or control surfaces. The direction of flight from the hedge trimming will aid in further search for the main scene.

A *splash* is caused when an aircraft has gone down into water: oil slicks, foam, and small bits of floating debris are apparent for a few hours after the impact. With time, the foam dissipates, the oil slicks spread and streak, and the debris become widely separated due to action of wind and currents. Sometimes emergency life rafts are ejected but, unless manned by survivors, will drift very rapidly with the wind. Oil slicks appear as smooth, slightly discolored areas on the surface and are in evidence for several hours after a splash; however, they are also caused by ships pumping their bilges and by offshore oil wells or natural oil seepage. Most aircraft sink very rapidly after ditching.

Additional Information

More detailed information on this topic is available in Chapter 5 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Setup: Provide the student with pictures of typical crash clues and wreckage patterns (e.g., Scanner slides).

Brief Student: You are a sUAS Mission Pilot/Technician trainee asked to identify and discuss typical crash clues and wreckage patterns.

Evaluation

<u>Performance measures</u>:	<u>Results</u>	
1. Identify and discuss typical visual crash clues and wreckage patterns that may be visible on FPV or on imagery and video feeds.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-0101

Demonstrate the Ability to Keep a Log

CONDITIONS

You have been assigned to keep a log on a mission, and must log the actions of your unit, section or team on the ICS Form 214 for use during debrief after the mission.

OBJECTIVES

Correctly maintain a log of actions during an incident.

TRAINING AND EVALUATION

Training Outline

1. When working an incident, staff members are required to maintain a log of all significant actions. This is important for record keeping of the accomplishments and setbacks, determining search effectiveness during debriefing, and as a legal record of CAP actions amongst many other things.

2. The mission log is started once a unit or section is opened and maintained until personnel are called in and at home safely to the incident commander. A separate log should be maintained for each varying unit or section that is assigned to the incident, and subordinate units at varying levels will normally also keep a log. This log is turned in with the debriefing paperwork and becomes part of the official mission record.

3. The following actions are always recorded in the log:

   UAS GROUND OPERATIONS
   a. Departure and return times to mission base
   b. Routes taken to and from the search area
   c. Times of entering and leaving search areas
   d. Any time the search line changes direction.
   e. Times/locations of clue detections or witness interviews
   f. Time/location of find
   g. Time/Location of communications checks
   h. Any event or action related to the team's ability to complete the sortie requirements (such as natural hazards encountered, or injuries to team members)
   i. Encounters or instructions from local authorities
   j. Encounters with the media
   k. Mileage/Flight time at key intersections, such as when leaving pavement or arriving at other key locations
   l. Time of distress beacon or other emergency signal acquisition
   m. Times distress beacon located and silenced. Also, if available, include the name(s) and organization(s) of person(s) involved in silencing the distress beacon, the manufacturer, serial number, dates of manufacture and battery expiration, vehicle information (type, vehicle registry, description), and the name of the owner.
   n. Personnel assignments to and from the team/unit

   Note: This log (ICSF 214) may be kept as an attachment to the CAPF 109.

   UAS AIRCREW OPERATIONS
      a. Briefing details

b. Names of crew members
c. Motor start time
d. Take Off time
e. Communications checks
f. Time beginning assigned grid or route
g. Time departing grid or route
h. Significant weather, turbulence, other
i. Time of landing/motor shutdown
j. Crew changes if any

Note: This log (ICSF 214) may be kept as an attachment to the CAPF 104.

MISSION BASE STAFF OPERATIONS

a. Time/date unit or log started or activated
b. Name of unit, supervisor, and individual keeping the log
c. Notes from initial briefing
d. Time and noted from staff meetings
e. Significant events, actions taken, direction received or provided

4. For each log entry, the log keeper writes down the following on the ICSF 214:
    a. The time
    b. The event taking place (see list above)
    c. Mileage and/or location as appropriate
    d. Name of individual annotating the log each time there is a change

Additional Information

Examples of other logs are available in Attachment 2 of the MART Vol. I, Mission Scanner Reference Text.

Evaluation Preparation

Setup: Prepare narrative of 10 events/actions and times. Provide the individual with the list, a pen, and an ICS Form 214.

Brief Student: Tell the student that he is the log keeper for his unit, and that the ten events listed in the narrative have occurred. Tell him to log the events/actions on the on team log form.

Note: This evaluation can be accomplished during a training exercise by observing the events taking place and checking the log to see that they are properly annotated.

Evaluation

Performance measures:	Results	
For each of the ten events/actions, the student:		
1. Logs the time and event.	P	F
2. Writes legibly and completely.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5113

Demonstrate How to Complete a CAP sUAS System Calibration and Aircraft Pre- and Post-flight Inspection

CONDITIONS

Given the Operating Instructions for the UAS to be calibrated and inspected, the UAS Mission Pilot/Technician will perform the required tasks.

OBJECTIVES

Correctly perform a required system calibration and perform an aircraft preflight and postflight inspection.

TRAINING AND EVALUATION

Training Outline

Calibrating the Compass

Only calibrate the compass when the DJI GO 4 app or the status indicator prompt you to do so. Observe the following rules when calibrating your compass:

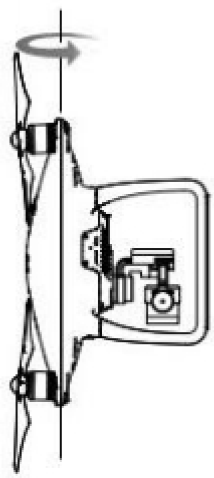
- DO NOT calibrate your compass where there is a chance of strong magnetic interference, such as magnetite, parking structures, and steel reinforcements underground.
- DO NOT carry ferromagnetic materials with you during calibration such as cellular phones.
- The DJI GO 4 app will prompt you to resolve the compass issue if the compass is affected by strong interference after calibration is complete. Follow the prompted instructions to resolve the compass issue.

Calibration Procedures

Choose an open area to carry out the following procedures.

1. Tap the Aircraft Status Bar in the app and select "Calibrate", then follow the on-screen instructions.
2. Hold the aircraft horizontally and rotate 360 degrees. The Aircraft Status Indicators will display a solid green light.

3. Hold the aircraft vertically, with nose pointing downward, and rotate it 360 degrees around the center axis.



4. Re-calibrate the aircraft if the aircraft status indicators glows blinking red.

⚠ • If the Aircraft Status Indicator blinks red and yellow after the calibration procedure, move your aircraft to a different location and try again.

• DO NOT calibrate the compass near metal objects such as a metal bridge, cars, scaffolding.
• If the aircraft status indicators are blinking red and yellow alternately after placing the aircraft on the ground, the compass has detected magnetic interference. Change your location.

Preflight Checklist

1. Remote controller, Intelligent Flight Battery, and mobile device are fully charged.
2. Propellers are mounted correctly and firmly.
3. Micro SD card has been inserted, if necessary.
4. Gimbal is functioning normally.
5. Motors can start and are functioning normally.
6. The DJI GO 4 app is successfully connected to the aircraft.
7. Ensure that the sensors for the Obstacle Sensing System are clean.

Additional Information

Additional information on how to properly perform component initializations and inspections is available in the UAS instruction guide, the manufacturer's website and information provided by third party sources.

Evaluation Preparation

Setup: Provide the trainee with a functional UAS and user guide. Additional documentation may also be provided, if available.

Brief trainee: You are a UAS Mission Pilot/Technician trainee and are required to inspect and perform a component initialization if necessary.

Evaluation

Performance measures:	Results	
1. Identify and discuss the process of initializing a compass, IMU, or gimbal.	P	F
2. Prepare the UAS for a flight and perform a preflight and post flight inspection.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.

P-5114

Discuss UAS Technician Duties and Responsibilities

CONDITIONS

You are a UAS Technician trainee and must discuss the UAS technician's responsibilities during a mission.

OBJECTIVES

Discuss the UAS Technician's responsibilities during a mission.

TRAINING AND EVALUATION

Training Outline

1. As a UAS Technician trainee, knowing your responsibilities during the mission is essential.
2. **UAS Technician and Sensor Operator**. There are some factors affecting Probability of Detection (POD) that you can control:

   a. Ask questions during briefings to ensure you really understand your assignment.

   b. Take the time with the Mission Pilot to plan the flight thoroughly and make sure you are prepared to fly it before you leave the mission base. This knowledge enables you to concentrate on the mission and "stay ahead of the aircraft," thus increasing search effectiveness.

   c. Recommend optimum altitude and airspeed. If you have to modify power on a southbound leg and increase power when you turn northbound in order to maintain a constant speed, then do it.

   d. Give a thorough debriefing and be brutally honest about your effectiveness.

   e. Stay proficient in your Technician, Observer, and Scanner skills.

3. **Observing for flight safety.** A principal responsibility of the UAS Technician is to maintain visual line of site (VLOS) view of the UAS through all phases of a mission. The Mission Pilot may be head down working with the control station or telemetry data and it is the UAS Tech who provides the continuous visual tracking of the UAS. There is no substitute for a dedicated and proficient observer who understands the limits and capabilities of UAS platforms and who works seamlessly with their UAS team.

4. **Scanning for the mission objective.** Another important use of the UAS Technician on a UAS Team is to monitor and scan the telemetry video output for objectives of the mission. This can be accomplished by plugging a second HDMI monitor into the tablet computer, or following a mission by scanning video brought back on the camera's Memory card. Either way, the terrain and video scanning is a job the Mission Pilot and the UAS Technician dedicated to Observing cannot do.

3. **Designing appropriate search patterns.** A skilled UAS Technician will be very knowledgeable in the use of Mission Planner software and in Search Theory and the design of Search Patters. This is a highly technical field and one which requires special expertise. The UAS Technician who designs search patterns to achieve mission objectives will usually brief the Mission Pilot and aircrew with an online simulation of the search pattern for review and update. Based on the plan and other known facts the UAS Technician will be able to calculate Probability of Detection for each flight.

6. **Providing the Mission Pilot with Technical Support -** A good UAS Technician manages the pilot's checklists and leads their employment by reading the checklist items for the Mission Pilot to accomplish and respond to. They anticipate the Mission Pilot's need for technical support. There are many areas in which UAS Technicians can specialize: Ground Control Station operations, Mission Planning, Geospatial Information Systems (GIS), Communications and Signaling, Sensor Operations, and Orthorectified Imagery Workflows.

7. **Managing Sensors and Sensor Output -** Based on the sensor payload, UAS Technicians may be monitoring visible imaging, infrared imaging, multispectral imaging, and video imaging concurrently, and storing and cross referencing the separate feeds for later exploitation. The UAS Tech may also set up and manage tracking antennas for control links, and load and maintain code for the Pixhawk flight controller.

Additional Information

More detailed information on this topic is available in CAPR 70-1U and in Chapter 9 of the Mart Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text.

Evaluation Preparation

Provide the student with a current copy of CAPR 70-1U and the Mart Vol. II, Mission Observer/SAR-DR Mission Pilot Reference Text.

Brief Trainee: You are a UAS Technician trainee and asked to discuss your responsibilities during a mission.

Evaluation

Performance measures:	Results	
Discuss your responsibilities during a mission:	P	F

a. How you can improve POD?

b. Observing for flight safety.

c. Scanning for the mission objective.

d. Designing appropriate search patterns.

e. Providing the Mission Pilot with Technical

f. Managing Sensors and Sensor Output Support

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly

Appendix