Advanced Digital Imagery System (ADIS)

Nikon D90 Camera Kit

-Checklist and Operations Manual-

V1.3

October 22, 2010

National Headquarters, Civil Air Patrol
Advanced Technology Group

1.0 Equipment Pre-Mission Check

1.1 Open the ruggedized camera case and verify the following items are enclosed:

Nikon D90 camera with attached Sigma 18-200 mm stabilized lens, Nikon MB-D80 Multi-Power Battery Pack, UV optical filter/lens protector and lens cap.
Sandisk (or equivalent) 8 GB SDHC memory card (may be stored in camera).
Nikon quick charger
2 – Rechargeable camera batteries (one stored in the camera multi-power pack)
6 AA battery fixture for use with the D80 Multi-Power Battery Pack (back-up camera power module)
Nikon GP-1 GPS
Nikon GP-1 to D90 camera cable (one end plugged into GP-1)
Camera to computer cable
Camera to TV video cable (used to view photos on a television set)
Garmin eTrex H GPS with 2 AA batteries
Cable pair for connecting Garmin eTrex to the Nikon D90 camera
Cable pair for connecting Garmin eTrex to a computer
Satechi TR-M Timer Remote Control with 2 AAA batteries
Instruction manuals for the camera, GP-1 GPS, Garmin eTrex H and TR-M Remote Control
Spare AA and AAA batteries

A cable is also enclosed that is used to connect the GP-1 GPS to a Nikon D200 camera. This cable is not for use with the D90 system.

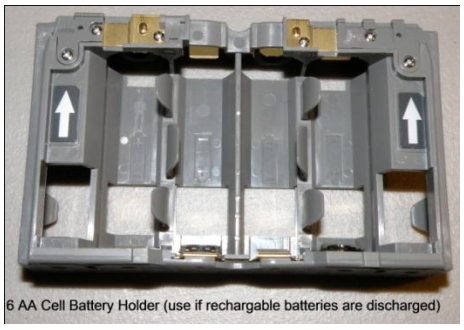
Photos on next page help with identification of components

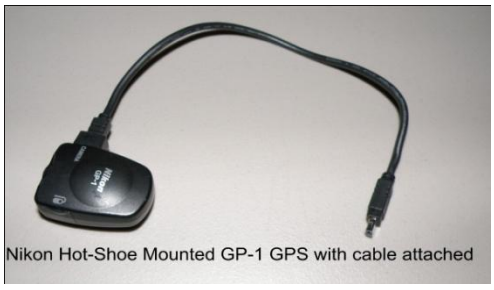
Photos of equipment located in the D90 System Case

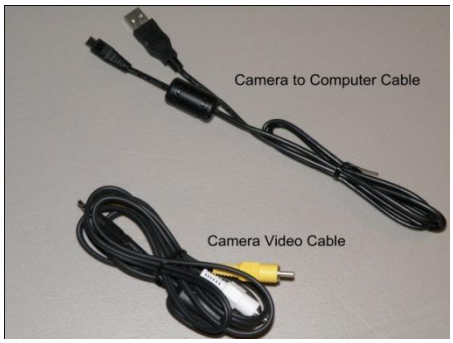
D90 camera with attachments

Battery pack

note: lens shield not used







Photos of equipment located in the D90 System Case

Garmin eTrex GPS to Nikon D90 Camera cable (one of two required)

Garmin eTrex GPS to computer cable (one of two required)

9-pin serial to USB Cable (needed to connect eTrex GPS to a computer)

AA batteries

Satechi Timer Remote Control with cable and two AAA batteries

Satechi Timer Remote with AAA batteries

An inexpensive tripod or monopod is not included in the D90 Kit provided by National Headquarters. Local purchase is recommended.

MonoPod (used to support camera during certain types of photo missions)

1.2 Charge Camera Batteries

Battery Pack Inserted in Charger

Plug in each battery pack, one at a time, and bring the batteries to full charge. The indicator light will flash during charging. When fully charged, the light will illuminate continuously.

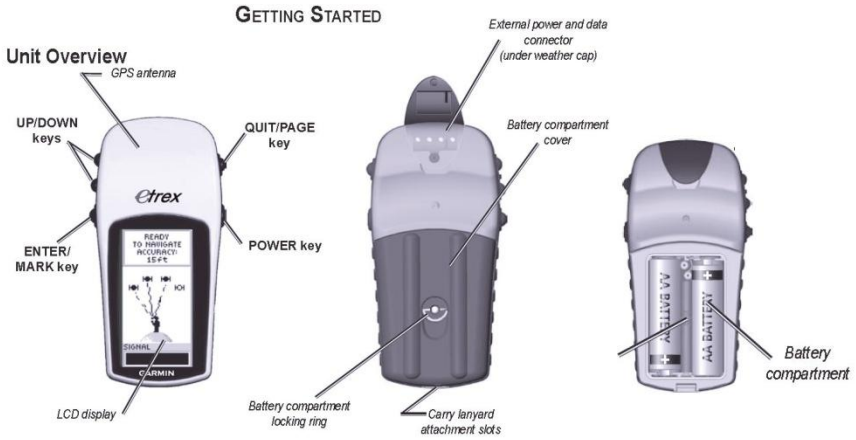
1.3 Check Garmin eTrex GPS for battery condition

The Garmin eTrex H is used to record a mission track log. A track log is required in order to determine aircraft direction, from which camera direction is determined. The eTrex also serves as a back-up GPS in the event the Nikon GP-1 GPS proves unable to remain locked onto the GPS satellite network which might happen when a mission is flown in mountainous terrain.

The Garmin eTrex GPS requires two AA batteries. Install as follows:

Remove the battery cover located on the back of the eTrex. Battery is replaced by turning the metal fastener on the back of the unit counter clockwise 90 degrees and then removing the back cover. Install 2AA batteries. Replace cover.

Turn on the Garmin etrex GPS *[right side second button from top]*. Push Page button *[top button right side]* until the Menu screen appears. At the bottom of the screen there is a battery indicator- it should be grayed in. If not more than 50% grayed in, replace battery. When done, push Power button until the unit turns off. *[right side, second button from top]*.



1.4 Nikon D90 Camera Pre-mission Initiation

<u>Verify the camera is turned off</u>

Install memory card (card may already be in the camera) by opening the door located on the right side of the camera and gentally pushing the card in until it clicks in place. A light located on the back-right of the camera will briefly illuminate to confirm the card is seated. The card can be removed by pushing the card in and it will pop out. One 8 GB card is furnished with the system. Local purchase of additional cards is recommended.

Set the lens autofocus switch to AF

Set the camera autofocus switch to AF

Just to the left of the camera AF switch is the lens optical stabilizer switch (OS). Place this switch to ON.

Rotate mode switch to "auto-no-flash". The Mode switch is located on the top-left side of the camera. "auto-no-flash" is reached by setting the Mode dial to "Auto" (green camera symbol) and then moving the Mode dial one notch counter-clockwise. Auto-no-flash assures the flash will not automatically pop up and contact the hot-shoe mounted GP-1 GPS module if a low light condition is encountered.

Set the focus selector switch to L

Install the garmin GP-1 hot-shoe mounted GPS

If the GP-1 cable is not attached to the GPS, do so by selecting the smaller of the two connector ends (the end does not have the words Nikon or CA 90 on it) and pushing it into the side of the GP-1 marked "camera" while lining up the arrows on the GP-1 and cable. Push it in until it snaps into place. The arrow on the cable will no longer be visible.

Plug the other end of the cable into the camera GPS port. The arrow on this cable end should be located so that it is visible from the back of the camera. This connection does not snap into place; just slide it in all the way.

It is recommended the GP-1 cable be left attached at the GP-1 end while in storage.

Install Camera Batteries

The Nikon MB-D80 Multi-Power Battery Pack is capable of holding two rechargeable batteries or six AA batteries. The camera will work properly with only one rechargeable battery installed. Two batteries give extended operation time. The six AA batteries are only used if the rechargeable batteries are discharged and there is no electrical power available to operate the charger, or if time is limited to allow for recharge.

The camera battery door is located on the back of the camera at the bottom. Flip out the latch and rotate it counter clockwise to open the door. Gentally press the white tab to the outside of the pack and then insert the battery as shown. To remove a battery, press the associated white tab to the outside of the pack and the battery will pop out.

If the AA battery accessory is used, install the six batteries while observing proper polarity. The accessory will move the white tabs as required.

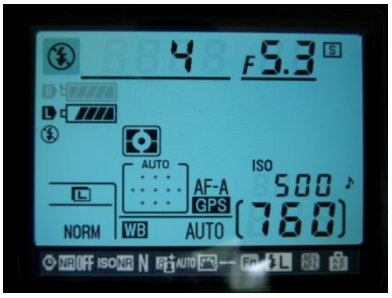
Remove Lens Cap

Turn on the camera

Check Batteries

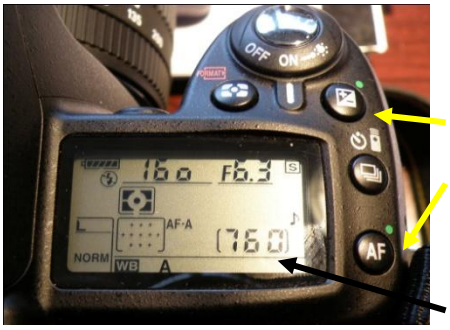
Note: the battery symbol above shows the status of the battery in use. When two batteries are installed it is better to follow the procedure below to check battery status.

Press the "Info" button to turn on the Monitor.



The following will show on the Monitor. Both batteries are shown; the active battery (chosen by the camera) and the standby battery.

Reset the Camera



Press the +/- and AF buttons. Hold them pressed for four seconds. The two buttons have green dots next to them. The Control Panel Display will flash to confirm reset has been completed.

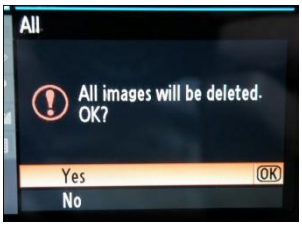
Control Panel Display

Clear the memory card

Press the Menu button to bring up the Menu Display on the Monitor.

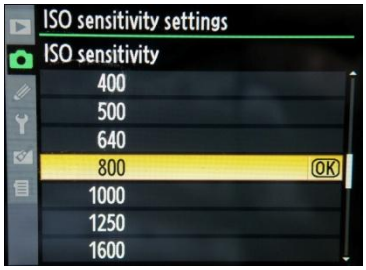
The Menu Display is navigated by pressing the up, down, left and right arrows on the Multi Selector. The Multi Selector also has an "OK" button located in its center.

Press the left arrow key on the Multi Selector in order to navigate the various Menu screens. Press the up and down keys to find the "Play Back" menu. Press the right key and then the up and/or down keys to select the Delete Menu. Press the right key to select the Delete Page and then move the up and/or down keys to select All All. Push the right key and then the up and/or down key to select "Yes" on the Delete All screen and then push the OK button. All images on the memory card will be erased.



<u>Set the sensitivity of the imaging receptor by adjusting it's ISO value.</u>

Press the Menu Button to bring up the Menu Screen. Press the left arrow key on the Multi Selector in order to navigate the various Menu screens. Press the up and down keys to find the "Shooting Menu". Press the right key and then the up and/or down keys to select ISO sensitivity setting. Press the right key to go to the ISO selection screen. Press the up and/or down keys to select the ISO value; a setting of 800 is suggested for aerial photography. Click OK.



<u>Check Camera Settings</u>

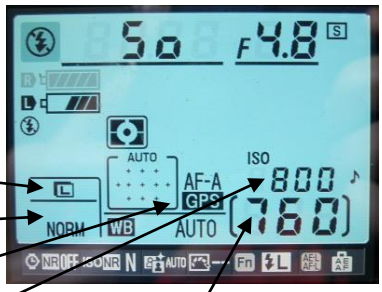
Press the Info button to bring up the Monitor Screen. The screen should look similar the one shown here.

Automatic Mode No Flash
Battery Condition
Large Picture Size

JPEG Setting to JPEG Normal

GPS Active and Locked onto the Network

ISO Set to 800
Memory capable of storing 2100 photos (2.1K)



1.5 Photo Check

The following is best done outside. Take both the camera and eTrex GPS.

Take a photo of anything; scenery, airplane, automobile, people, hanger…etc. Hold the shutter button down half way for a second to allow the lens to auto-focus. Press the shutter button all the way down to take the photo.

Check the results.
Press the Playback button.
The picture will appear on the Monitor.
The photo should be sharp and properly exposed.

Push the Multi Selector "up" button to see the shooting data display. The display shows the f-stop, shutter speed, ISO value, lens focal length and an icon confirming the camera is set to the auto mode with no flash.

Press the Multi Selector "up" button one more time to view the latitude, longitude, altitude, and time and date. Presence of this data shows that the GP-1 GPS is working correctly. Note that altitude is in meters.

Delete the Photo

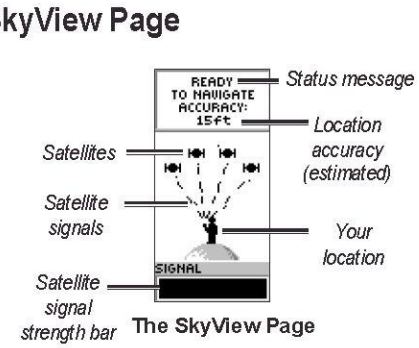
Press the Delete Button twice to delete the photo just taken.

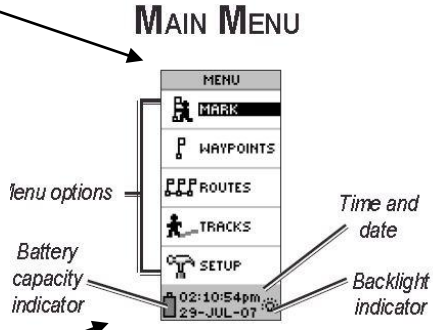
1.6 Synchronize the eTrex and Camera Clocks and clear the Track Log

The track log recorded by the eTrex GPS will be coordinated with camera photographs during post-processing of mission data. The coordination is done by matching photo time and eTrex GPS time.

Turn on the eTrex. Push the Page Button several times until the SkyView page appears. Wait until the status message "Ready to Navigate" appears.

Push the Page Button several times until the Main Menu screen appears.





<u>Clear the Track Log.</u> Use the up/down buttons to Select Tracks then press the Enter button. Select Clear and then press Enter. Select Yes at the message.

<u>Set the camera clock</u>

The time will appear at the bottom of the eTrex Main Menu page. Keep this display active while the camera is set to the same time.

Push the camera menu button. Press the Multi Selector left button and then press the up and/or down buttons until the "Setup Menu" appears. Press the right button. Press the up and/or down buttons until "World Time" is highlighted. Press the right button to bring up the "World Time" screen. Press the up and/or down buttons to highlight "Date and Time". Press the right button to bring up the "World Time Date and Time" screen. Use the right button to scroll through the settings while using the up and down buttons to set Year, Month and Day and then Hour, Minutes and Seconds. Set the time a minute faster than eTrex time; once the hour, minute and seconds are identical, press the OK button. Return to the World Time screen (time is at the bottom) to check that the eTrex and camera are now time-synchronized.

1.7 The Multi Function Timer Remote Control

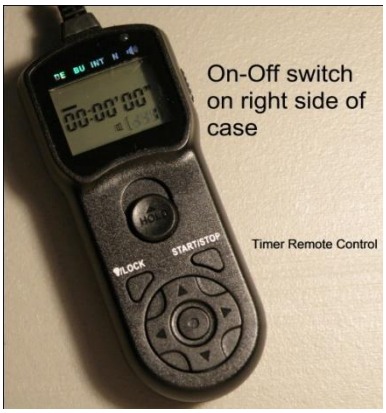
Some aerial photography missions require multiple photos be taken in accurate time sequence. Obtaining multiple overlapping photographs of a road, shoreline or river is one example. Another is imaging a large area with multiple photographs overlapping in two dimensions. At the speed and altitude typically flown by CAP aircraft, for these types of missions, the time between photographs is typically 4 seconds. The Multi Function Timer Remote Control included with the D90 camera system kit will automate the shutter release.


Satechi Timer Remote Control with cable and two AAA batteries

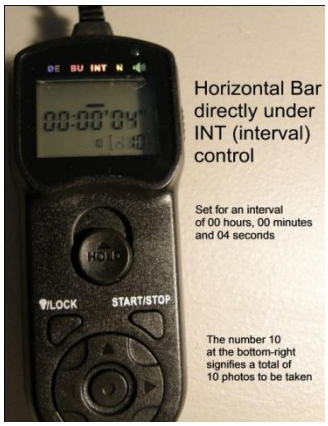
Install two AAA batteries in the Timer Remote Control. The battery compartment access is at the rear of the unit.

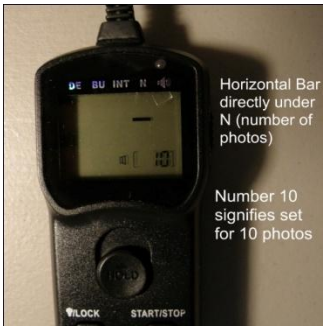
Turn the unit on.

The Timer Remote Control is able to operate in several modes. The mode of interest for aerial photography is timed interval (shown as IT on the front face of the unit). Two settings must be defined for this mode; time between shutter releases and total number of photos to be taken while in automatic mode.



Use the left, right, up and down pushbuttons to select the time interval. Using the right button, move the horizontal bar until it is below INT. Press the Set push button located in the center of the direction selector. The hours will blink on and off. Use the right pushbutton until the seconds blink. Use the up pushbutton to set the time to the required number of seconds between photos. Press Set again.





Press the right pushbutton to move the horizontal bar to the right until it is under N. Press Set. Use the up and down pushbuttons to enter the number of photos to be taken (10 for example). Press Set again.

Press the left pushbutton to move the horizontal bar below INT. The unit will now display the time interval and total number of photos.

The Timer Remote Control cable plugs into the right side of the Nikon GP-1 GPS. The arrow on the unit's cable faces up when plugged into the GP-1.

Activate the Timer Remote Control by pushing the Start/Stop button. Push the button a second time to stop automatic operation.

Note: the camera must be photographing an adequately lighted subject in order for the shutter to close automatically. Do not attempt to test the camera and timer remote control with the lens cap on the camera!

1.8 The Camera and associated equipment are now ready for an aerial photo mission.

Turn off the camera, eTrex GPS and the Remote Timer Control now that the Equipment Pre Mission Check has been completed!

Put the lens cap back on the camera!

2.0 Pre-Mission Planning

2.1 Identify Customer Requirements

The flight crew needs the following information to assure successful acquisition of the aerial photographs required by the customer:

Type of mission. The major types are:
- ✓ Spot Photography
- ✓ Route Photography
- ✓ Photographic Mapping

Location
- ✓ Target location(s) for spot photography
- ✓ Beginning and end of a route (highway, shoreline, river)
    - o Percent of successive photo overlap
- ✓ Corner point coordinates defining area for photographic mapping
    - o Amounts of successive photo overlap and parallel photo overlap

Ground level coverage of each photograph (how many feet wide and how many feet deep)

Camera pointing angle (how many degrees down from the horizontal)

Resolution at ground level at the center of the photograph

2.2 Translate customer requirements into specific photographic shooting parameters to include:

- ✓ Altitude above ground (AGL)
- ✓ Aircraft speed
- ✓ Camera pointing angle
- ✓ Lens focal length
- ✓ Time between photographs (required for route photography and photographic mapping)

Altitude above ground level (AGL)

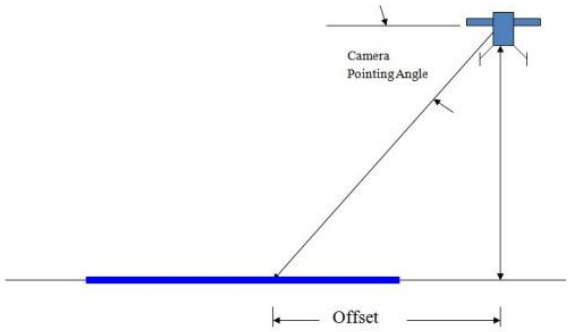
1200 feet AGL is an ideal altitude for aerial photography; the closer to the ground, the less build-up of haze and thus a clearer photograph. Higher altitudes allow for more ground coverage per picture but at lower ground resolution.

Aircraft Speed

At 90 Knots, the aircraft moves 150 feet per second. This is a good speed for aerial photography.

Camera Pointing Angle

Camera pointing angle is the angle below the horizon.



In a Cessna 182 or Cessna 172 with a photo window it is not possible to get a pointing angle much greater than 45 degrees. Smaller angles result in the photos being greater in extent perpendicular to the direction of flight and thus lower resolution at ground-level. Haze also becomes more significant at smaller pointing angles. 45 degrees is an excellent choice although 30 degrees is a reasonable compromise.

Setting Camera Pointing Angle

Taking photos with a consistent pointing angle requires the use of a monopod. The following pictures show how one squadron sets the pointing angle using a locally fabricated guide. The guide shown is for 45 degrees.

Camera mounted to monopod. Ponting angle set using guide.

Mono pod rests on seat. Photographer holds monopod so camera does not rest against the photo window

Lens set to 45 degrees

Lens Focal Length

The 18mm to 200 mm lens furnished with the Nikon D90 Kit covers a wide range of photographic requirements, from wide angle to long-telephoto. Focal length settings less than 50 mm are not useful when the camera is used in a Cessna 182 or Cessna 172 equipped with a photo window. Taking photos at focal length settings from 18mm to approximately 40mm results in the picture including parts of the aircraft (landing gear, wing). Customers do not want parts of the aircraft in the photo. In addition, when parts of the aircraft are in the photo field, the camera's automatic focus and exposure devices may not work correctly; the landing gear may be in focus but the scene below may not!

Focal length is set by rotating the focal length ring.

Focal length setting

Choosing the best camera Pointing Angle and lens Focal Length

Consult the following table to select shooting parameters. Data is given for an aircraft altitude of 1200 feet AGL. The data can be scaled for other altitudes as the scaling is linear. Example, to fly at 1800 feet AGL, multiply the number in the rows "Horizontal Image dimension in direction of flight" and below by 1800/1200 = 1.5.

Base upon the customer's requirement for image size at ground level, go down the table and find the closest fit. For example, if the customer wants each photo to be about 800 feet by 600 feet, choose the first data column; 812 feet horizontal and 847 feet perpendicular to the direction of flight is a close fit. From that column, find the required lens focal length (50 mm) and camera pointing angle (45 degrees). The bottom data entry in the column indicates that the aircraft will need to be directed to a point 1200 feet from the target. Resolution at the center of the photo will be 2.3 inches!

Important – the data in the table applies to the Nikon D90 camera. Most of the data also applies to the Nikon D200 although resolution values will be reduced slightly. For other cameras, the data may be way off as other cameras may have different image sensor dimensions.

Nikon D90 Aerial Photography Imaging Parameters						
Image Sensor Pixels = 4288 x 2848		From Nikon D90 Specifications				
Sensor horizontal dimension (mm)	23.6	From Nikon D90 Specifications				
Sensor Vertical dimension (mm)	15.8	From Nikon D90 Specifications				
Altitude (ft)	**1200**	**1200**	**1200**	**1200**	**1200**	**1200**
Lens Focal Length (mm)	**50**	**50**	**50**	**100**	**100**	**100**
Field of View(horizontal) degrees	**27**	**27**	**27**	**13.5**	**13.5**	**13.5**
Field of View (vertical) degrees	**18.1**	**18.1**	**18.1**	**9.1**	**9.1**	**9.1**
Pointing angle below horizon (degrees)	**45**	**30**	**15**	**45**	**30**	**15**
Horizontal Image dimension in direction of flight (ft)	**812**	**1160**	**2241**	**398**	**568**	**1097**
Vertical image direction perpendicular to direction of flight	**847**	**1728**	**8928**	**396**	**786**	**3120**
Pixel resolution at center of image frame - horizontal (inches)	**2.3**	**3.2**	**6.3**	**1.1**	**1.6**	**3.1**
Distance of camera axis at ground from ground directly below aircraft (ft)	**1200**	**2078**	**4478**	**1200**	**2078**	**4478**

For shallow camera pointing angles (see the 15 degree entry) the dimensions of each photograph for a 50 mm lens focal length become very large (approximately 2240 feet horizontal by 8900 feet perpendicular to the aircraft). Resolution is lower at the center of the camera axis; it becomes significantly degraded near the edges of the photo.

Telephoto focal length settings (greater than 50 mm) provide increased resolution with smaller ground-level coverage. See the 100 mm data entries. Where maximum detail is required, use of a telephoto lens setting adds value.

Maintaining a Focal Length Setting

During route photography and aerial mapping it is important that the lens focal length setting not change. There is no built-in mechanism to lock the focal length setting at any value other than 18 mm. The following photo shows a simple solution.

Where overlapping photographs are required, the time between shutter-release must be determined. A 25% photo overlap is a good choice and will be used as an example. Horizontal picture dimension should have already been determined in the steps above. If shooting parameters result in each photo nominally covering 800 feet at ground level, 25% overlap means that a photo should be taken every time the aircraft moves (100%-25%) x 800 feet = 600 feet. At 90 knots, the aircraft moves 150 feet in one second. Therefore, a photo must be taken every four seconds. Program the Multi Function Timer Remote Control for four seconds.

Determining Number of Photos

For spot photography, take multiple photos as appropriate. More are better than less!

For route photography and aerial mapping, one must determine the length of each leg. Using a map, determine each leg length in statute miles. Multiply the leg length in statute miles by 5280 feet per mile. Divide that number by the length of each photo less the photo overlap (see "Selecting a Time Interval" above). The result is the number of photos that need to be taken during the leg. Program the Multi Function Timer Remote Control with the result. For example, for a leg length of 8 miles and a 25% overlap of photos with each photo 800 feet wide, 5280x8=42,240. (100%-25%) x 800 feet = 600 feet. 42,240/600 = 70 photos.

4.0 Flying the Mission

4.1 Pre Engine Start

Take a picture of the tail number of the aircraft.

Brief the pilot and observer on missions details; altitude, ground speed, target location(s) and type. Agree on how you will direct the aircraft once in the target area.

Ask for an "in case of emergency" briefing in the event the pilot has not already done so. If the flight is to be over water, ensure the briefing includes ditching instructions and that you, the pilot and observer crew are wearing approved life vests.

Turn on the Garmin eTrex GPS. Place it where it will have a clear view of the sky. It may be placed on the dash board providing it does not obscure the view of the pilot or observer. Another good location is to suspend it under the rear window. After a few minutes, confirm the unit has locked onto the satellite network. If the track log was not erased during the pre-mission check, do it now!

Note: the aircraft needs to be outside of a metal hanger in order for the GPS receivers to function correctly.

Remove the lens cap. Store it somewhere where it will not blow around the cockpit.

Turn on the camera. After a minute or so, verify that the GP-1 GPS is locked onto the satellite network. Point the camera out the photo window and take a picture. Verify that the photo is sharp, properly exposed and that the GPS data has been included in the photo. See section 1.5 above for details.

If the Multi Function Timer Remote Control will be used during the mission, connect it to the GP-1-GPS. Turn it on and confirm proper programming. Point the camera out the photo window and activate the Timer Remote Control (push "start") and verify it takes multiple photos at the correct time interval. Press stop to quit taking photos. See section 1.7 above for details.

4.2 Flight Segment

Tell the pilot you are ready for engine start.

Once the engine is running, make sure your can talk to the pilot and observer using the intercom. If not, do not proceed until this is resolved. You must be able to talk to the pilot in order to give steering directions once in the target area.

Once in the target area:

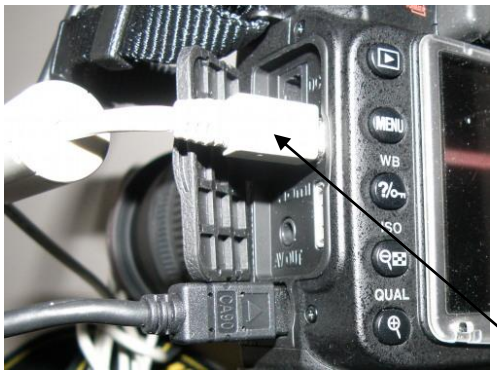
- ✓ Locate the target(s)

- ✓ Use the previously determined lens focal length setting or, for spot photography, zoom as appropriate (make sure aircraft parts will not be in the picture).
- ✓ It is ok to put the camera lens outside the photo window but make sure the focal length setting does not change.
- ✓ Provide instructions to the pilot on flight path.
- ✓ Direct the aircraft so that the center of the camera view finder is on the target.
- ✓ Push shutter button down half way and hold for a second before taking the photo to allow for auto focus to lock-on.
- ✓ Take multiple photos.

Note: if the Timer Remote Control is used, the camera will automatically pre-focus before closing the shutter. The only thing the photographer needs to do is to start the sequence and then hold the camera steady during the leg.

Use of a laptop while airborne

If the mission requires the use of a laptop for photo download during the flight segment of the mission, use the camera to USB cable to make the connection.



Cable connection at camera end

USB to Computer Connection

4.3 After the Flight

- ✓ Turn off camera, the Garmin eTrex GPS and the Remote Timer
- ✓ Disconnect cables as required
- ✓ Replace the camera lens cap
- ✓ Take the camera and the eTrex GPS to mission base for photo processing

4.4 After Photo Processing

- ✓ Verify camera and Garmin eTrex are turned off
- ✓ Charge both camera batteries
- ✓ Remove the batteries from the Remote Timer
- ✓ Account for all components and place them back into the ruggedized storage and carrying case