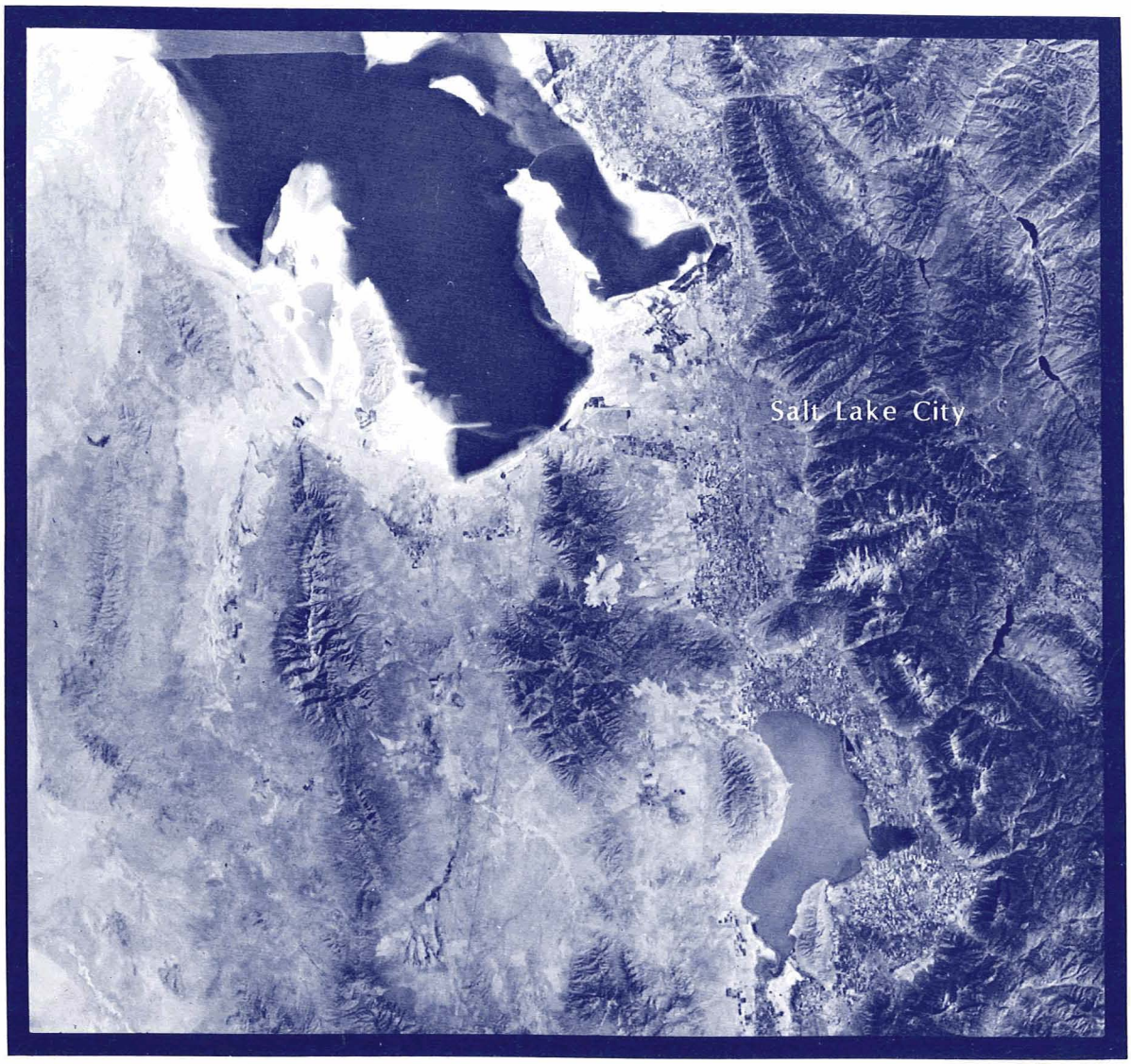
CENTER FOR REMOTE SENSING AND CARTOGRAPHY

ENVIROPOD HANDBOOK

A Guide to Preparation and Use of
the Environmental Protection Agency's
Light-Weight Aerial Camera System

CRSC Report 84-1



UNIVERSITY OF UTAH RESEARCH INSTITUTE

Salt Lake City

ENVIROPOD HANDBOOK

A Guide to Preparation and Use of
the Environmental Protection Agency's
Light-Weight Aerial Camera System

CRSC Report 84-1

By

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Environmental Protection Agency, Region VIII
Denver, Colorado

Gary A. Shelton
Remote Sensing Specialist
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Environmental Protection Agency
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TABLE OF CONTENTS

I. INTRODUCTION

A. Objective

This handbook outlines the basic steps entailed in the use of the Environmental Protection Agency (EPA) Enviropod Camera System. It contains a step-by-step guide for mission planning, flights, film processing, indexing, and documentation. The handbook also provides information regarding Enviropod equipment and specifications.

B. Example of Enviropod Mission

In order to best illustrate the execution of an Enviropod mission in a practical way, a particular mission that was previously completed has been selected as an example. This specific mission was for the Utah Department of Wildlife Resources to document river channel disturbance on the Weber River in Morgan and Summit Counties, Utah. While specific reference will be made to this particular mission, all aspects of planning and execution are discussed in order to cover possible requirements for any given Enviropod mission.

II. ENVIROPOD SYSTEM CONFIGURATION

A. Aircraft and the Pod

Two aircraft types have been approved by the Federal Aviation Administration (FAA) to carry the Enviropod: the Cessna 172 and Cessna 182. Exhibit A includes a copy of the approval form for each aircraft. The form, as well as placard "a" and "b" of limitation number 4, must be placed in the aircraft during actual operation.

The two-part Enviropod capsule, in which the cameras are mounted, is an aluminum enclosure that straps to the bottom of the aircraft

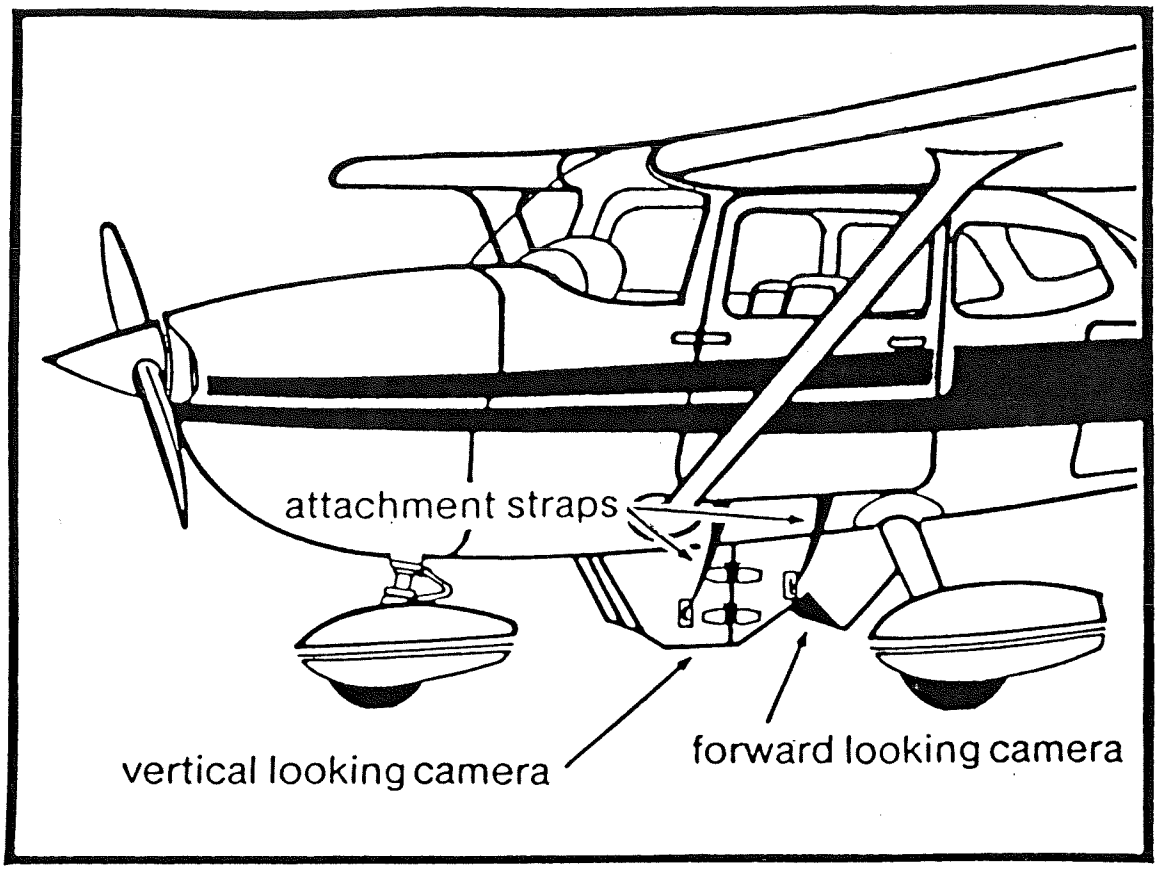
(Figure 1). The pod, when snapped together, measures 48" in length, 16" in width, and 13" in height. When mounted, the bottom of the pod should be a minimum of 4" above the ground.

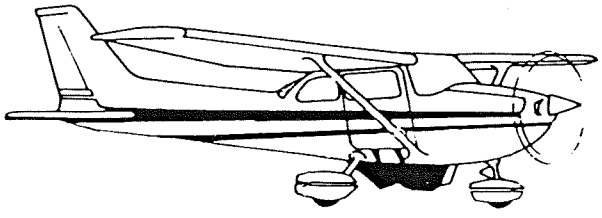
The pod is fitted with either a DC battery power supply (two batteries for each of the two cameras) or the cameras may be run off the aircraft's electrical system through a cigarette lighter adapter. The latter is usually more convenient because of the reduction in weight. The weight of the pod with camera is 78 pounds, while the four batteries add another 67 pounds. This increase in weight adds to the chore of mounting the system to the aircraft. The batteries must also be charged and ready for a given flight. An AC charger has been made available from the EPA.

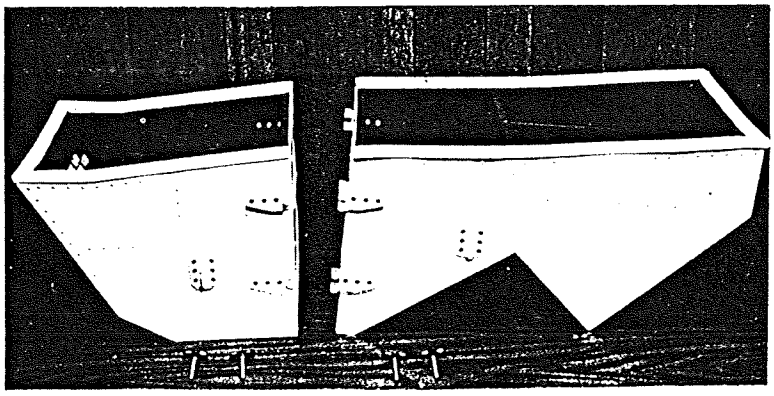
Enviropod contains two camera ports, one vertical, the other at a 45 degree forward oblique angle. The glass windows on the pod are provided with aluminum protective plates which must be removed prior to takeoff. These glass windows may be abraded by airborne particles near the ground during takeoff and landing, especially on remote airstrips.

B. Cameras and Film

Enviropod was designed to carry two KA-85A panoramic cameras, although it is adaptable to various other camera systems (e.g. Hasselblad). These panoramic cameras contain 80mm lens with f/2.8 to f/22 aperature. They use 70mm "Kodak Aerochrome infrared film 2443 (Estar base)" Catalog 160 8462 for color infrared; and "Kodak Aerochrome MS film 2448 (Estar base)" Cat. 168-4166 for natural color photography. Both of these film types are high quality, fine grain film, depicting remarkable detail. The fine grain and resulting spatial resolution permit enlargement up to 30x or more without significant loss of definition.







Enviro-Pod Sections Before Mating.

Figure 1

Since most applications may benefit from both natural color and CIR photography, CRSC's typical procedure is to place one film type in the vertical camera, and the other type in the oblique camera. The particular order depends on the nature and objectives of the individual mission. Information concerning film ordering can be obtained through the EPA.

Since the image is exposed through a rotating lens onto a concave surface, rather than a film plane, scale of the final film product decreases from the center outward. An individual film image measures 2.3 inches (along flight line) by 7.6 inches (transverse to flight line).

For the camera mounted in the vertical port the scale along track may be predetermined during flight planning. While the scale perpendicular to the flight line is variable, the approximate width of the ground swath may be predetermined as well. Both scale and swath width are functions of flying altitude, terrain configuration, and altitude of aircraft over the target area. These matters are discussed later in this handbook.

For the camera mounted in the forward looking oblique port, scale varies in both directions on the image. The ground swath coverage can only be roughly approximated. The resulting image is best used for reconnaissance and interpretative use by way of visual landmark control since the image geometry is greatly distorted.

C. Intervalometer

For each Enviropod mission an intervalometer is placed in the aircraft to trigger the cameras on an auto-timed sequence. The intervalometer may be set individually, for each camera, to the nearest tenth of a second. In addition to the automatic cycling, each camera may also be triggered by the photographer. The extra picture button will not interrupt the auto-timed sequence of exposures.

Electrical leads from the intervalometer run under the door of the cabin to the pod. Appropriate padding is required to prevent vibrations from severing these wires. The usual padding configuration consists of five layers of duct tape along the bottom door jam (for cushioning); followed by the intervalometer cable; then overlaid with three more layers of duct tape to prevent chafing.

III. PREFLIGHT PREPARATIONS

A. Mission Planning

Exhibit B contains the various mission planning forms and tables needed in the execution of a typical Enviropod mission. These forms and tables keep vital mission information in a convenient, easy-to-locate format. The first page contains information provided by the requesting organization. (If the client does not know what scale is adequate, or is limited to a fixed cost, refer to "Mission Delineation" in the next section.) Page 2 and 3 of Exhibit B contain convenient tables of mission planning data and flight calculations. The last form is the Flight Log. The header information should be filled out during preflight preparation. The lower part is useful in the case of multiple straight flight lines in a given mission.

Once an altitude above ground level (or scale) has been determined, the flight line can now be mapped. If the target area is linear and no wider than a single flight line requirement (e.g. a river, canyon, shoreline, etc.) a line delineated on a xerox map of target area is sufficient. However, if the target is broader, multiple passes will be required to cover the entire area.

The initial discussion will deal with the simpler case of a linear target. The flight line should be drawn onto a xerox copy of a portion of

a USGS quadrangle. This map will be carried in the airplane to aid the photographer and pilot in locating the beginning and end of the target path. The map should also contain altitude levels the aircraft must maintain along the flight path.

For the Weber River mission example, an altitude above ground level (AGL) of 2,500 feet was selected, with coverage of the river starting at Rockport Lake and extending to the Great Salt Lake. Every three to five miles along the flight line, or at any substantial break in topography, the elevation above sea level is calculated by adding ground elevation and AGL (Figure 2).

When multiple passes are required, the flight planner must consider not only the forward coverage per frame but also the lateral coverage. Information regarding forward and lateral coverage may be found on Page 2 of Exhibit B and on the graphs in Exhibit C. Warning: always subtract at least 40% for lateral sidelap to provide a buffer zone. The actual amount of sidelap depends on how much detail is needed in the fringe area.

Once the flight lines have been laid out to provide the needed coverage, they should be referenced to easily identified objects on the ground (e.g. roads, towns, river confluences, etc.) This enables the pilot to be kept on course, and prevents loss of coverage at the fringe of the photograph.

To illustrate this type of coverage see Figure 3, where the bold lines show line of flight and dashed lines determine limit of lateral coverage with an appropriate buffer already subtracted. This particular example is of Antelope Island at 3,000 feet AGL. The actual lateral coverage is 2.44 miles, minus .55 mile for a buffer, leaving a net 1.9 miles of lateral coverage to plan for.

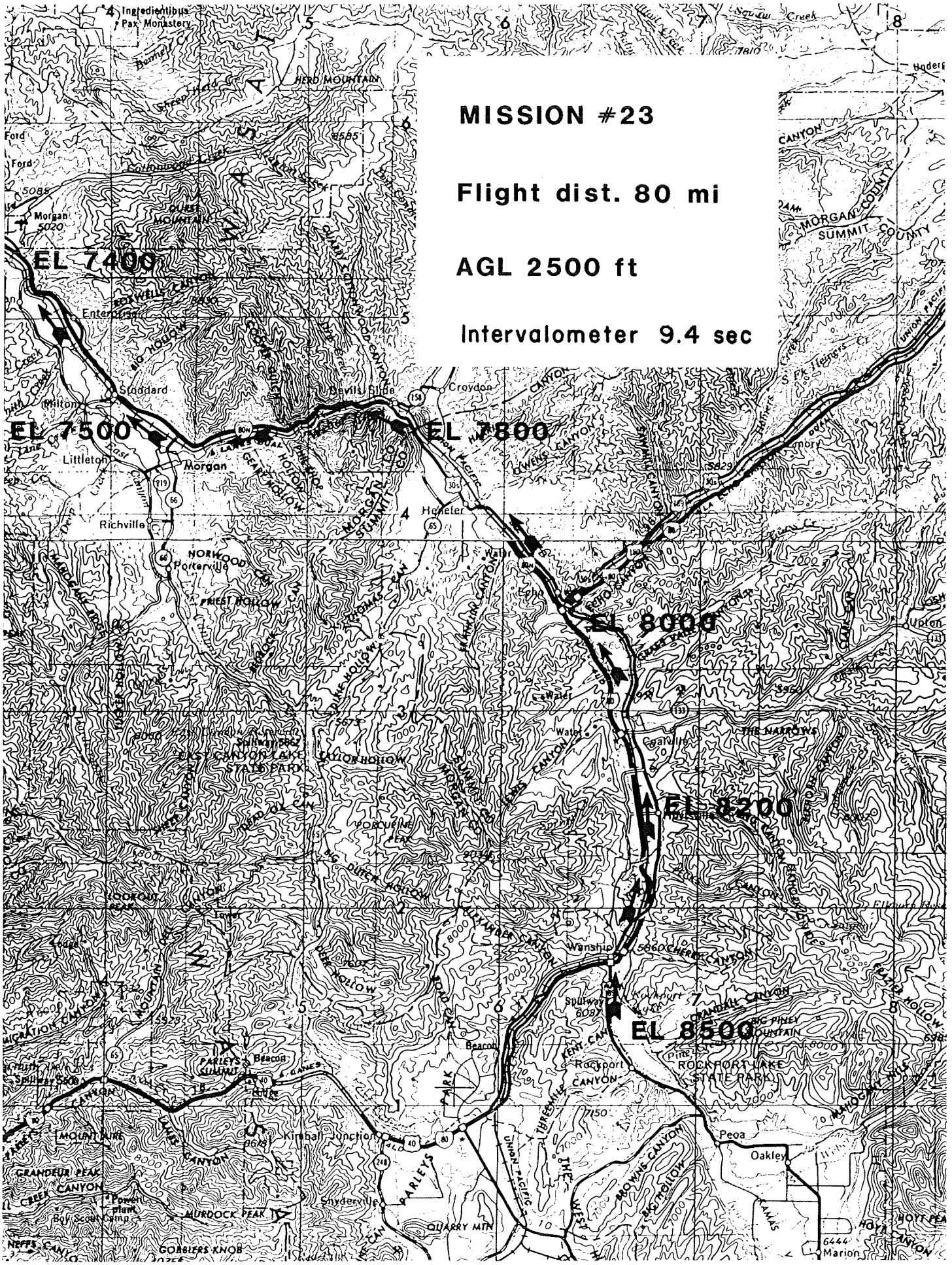

MISSION #23
Flight dist. 80 mi
AGL 2500 ft
Intervalometer 9.4 sec
EL 7400
EL 7500
EL 7800
EL 8000
EL 8200
EL 8500

FIGURE 2

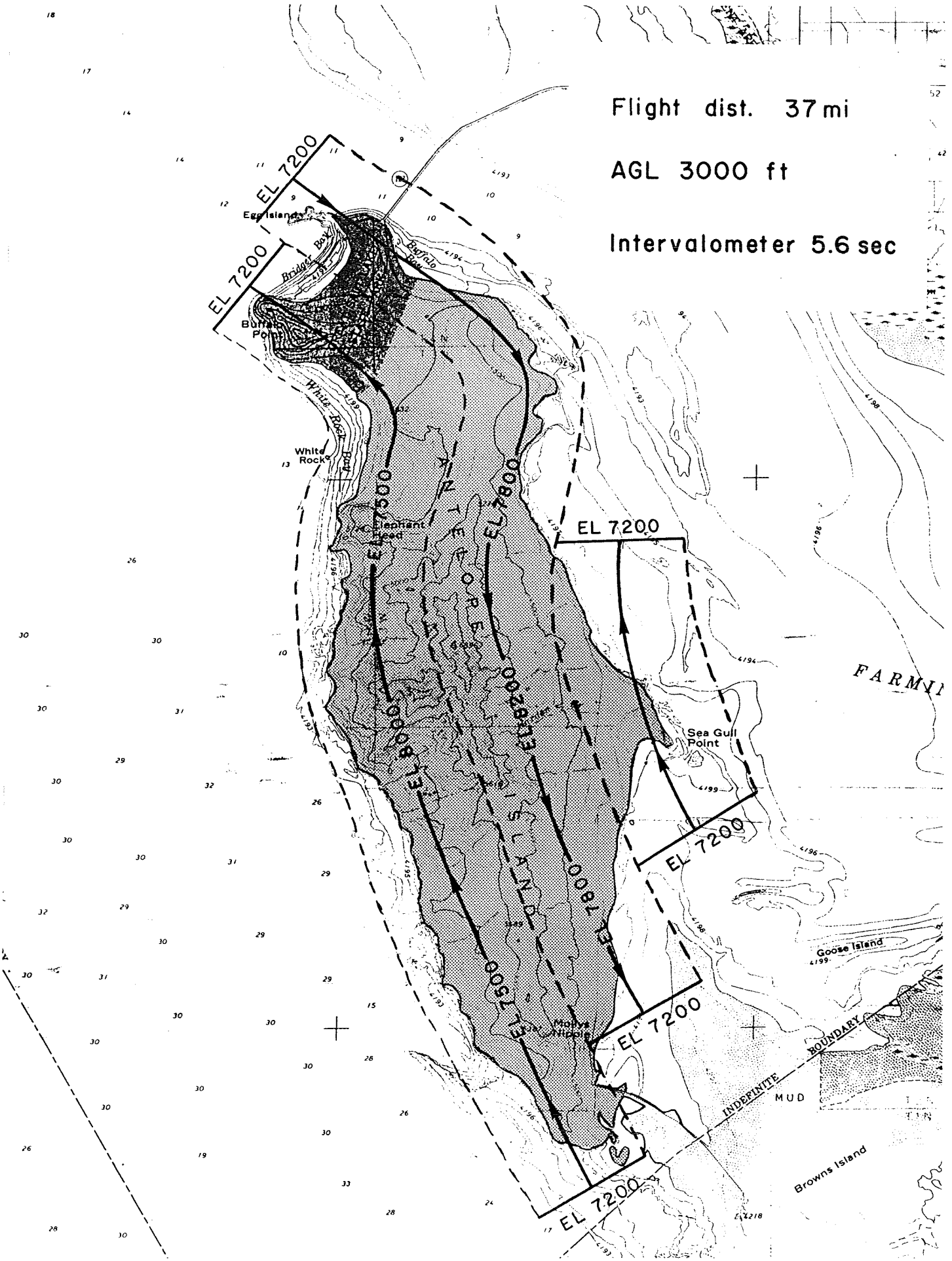

Flight dist. 37 mi
AGL 3000 ft
Intervalometer 5.6 sec
EL 7200
EL 7200
EL 7200
EL 7200
EL 7200
EL 7200
EL 7200
EL 7500
EL 7800
EL 8000
EL 7800
EL 7500
Egg Island
Buffalo Point
Buffalo Bay
Bridal Bay
White Rock
White Rock Bay
Elephant Head
Sea Gull Point
Goose Island
Maple Hillside
INDEFINITE BOUNDARY
MUD
Browns Island
FARMI

FIGURE 3

After the flight line has been mapped, the required amount of film can be calculated. To find the amount of film needed for a given length of flight, divide the flight length by the amount of forward advance per frame (derived from Page 2 of Exhibit B). This determines the number of frames of photography needed. Divide the number of frames by 1.5 (1.5 frames per foot of film) to give footage of film required for the mission. If the footage required is not acceptable for economic or other reasons, refer to "Mission Delineation" in the next section to reevaluate what is required from the mission.

The intervalometer setting determines how often the camera exposes a frame. The optimum setting is found on Page 2 of Exhibit B for various altitudes at a ground speed of 90 knots. For various other speeds and overlap selections, refer to Exhibit C.

A forward overlap of photographs is usually desirable to provide a buffer to account for deviations in the flight speed, AGL, etc. An overlap of 20% is typically used for monoscopic photography and an overlap of 60% is used to provide steroscopic coverage when desired.

A completed Mission Request Form (B-1), Flight Log (B-4), and map of target area are the end results of a flight planning session. This map should have the flight line delineated, altitude above sea level identified, and the intervalometer setting. The map should also be trimmed small enough to be placed on a clipboard with other flight material.

B. Mission Delineation

While many clients will not have a clearly defined idea about what scale of photography they need, they may have a specific amount of funds allocated. To optimize economy, the mission planner may be required to

derive several preliminary flight plans in order to determine which provides complete coverage on a limited amount of film. Optimum economy is reached when a full roll of film for a given camera is used for one mission. If the desired coverage cannot be accomplished on one roll, then it will be necessary to land the aircraft, dismount the pod, and install another roll.

For these preliminary flight plans it may be sufficient to find flight length, then adjust AGL to effect the needed coverage for the available film. Check the scale at the selected AGL to determine if photography will provide sufficient detail for the project.

In the process of examining the many different flight combinations possible, the use of the tables and graphs in Exhibit C can become cumbersome. For those with access to a Hewlett-Packard 41CV (or 41C plus one additional memory module), the program in Exhibit D will greatly increase the planner's ability to examine many possible flight plans quickly and efficiently. Instructions for program loading and execution are found in Exhibit D.

C. Camera Loading and Downloading

Before describing the actual installation and removal of film from the Enviropod cameras, it should be noted that after changing ANYTHING on a camera (i.e., remove/install film or change f-stop) it should be labeled on the outside of the camera. A convenient way to label the camera is to use masking tape with the current condition of camera written on it. This label should display the film type, amount of film (footage), as well as the present f-stop. If this practice is adhered to, it will reduce the chance of accidentally opening a loaded camera and ruining the film, or mistaking the type of film or amount of film remaining on the roll.

Ideally, the camera should be loaded and unloaded in a darkroom; however, if no darkroom is available or if film must be changed in the field, a dark bag can be used. Whether you use a dark bag or a darkroom it is advisable to familarize yourself with the camera mechanism by loading and unloading an old piece of film leader before attempting to load unexposed film.

The process for loading and downloading the camera in the dark bag is the same as that for a darkroom except that you will be guided by touch only. It is essential that all the equipment needed to complete the loading/unloading process be inside the dark bag prior to opening the camera. The equipment needed usually includes the following:

1- camera

2- light-proof film container

3- empty film core (take-up spool)

4- scissors for cutting film

5- masking tape for securing the loose ends of the film on the take-up spool

Exhibit E contains a step-by-step guide for film loading and unloading. Important: If the film being installed/removed is secured by tape to the feed or take-up spool, be certain that no tape is allowed to be forced into any of the drive mechanisms. If tape disappears into this area it can jam the drive mechanism, requiring disassembly of the camera.

After the cameras have been loaded with the appropriate film, the f-stop must be calculated and set for each camera. Through field experience, CRSC has developed the charts and graphs in Exhibit F. The f-stop obtained from these charts are representative of typical conditions encountered by CRSC. Variations in cloud cover, target brightness, and

haze conditions may necessitate adjustments to the f-stops obtained from Exhibit F. To find f-stop, refer to the chart with the latitude closest to that of the particular mission. A solar altitude is derived from the graph by time of year and time of day. This solar altitude is then used with the table to obtain the correct f-stop.

The final step of camera preparation is to install a #2 yellow filter on any camera containing color infrared film. It would be advisable to label each camera at this time with the film type, f-stop, and filter used (if any).

At this point, we have completed the Mission Request Form, a map with the flight line data, and the cameras are loaded and ready to use.

Preflight Checklist

This section introduces a detailed checklist for the mounting and dismounting of the Enviropod. If the photographer adheres to this guide, optimum performance from Enviropod will be realized -- resulting in high quality aerial photography. While the checklist is very thorough, some topics deserve particular emphasis:

1. Before leaving for the airport make sure you have:
   - Charged the batteries
   - Correct pod mounting straps (Cessna 172 or 182)
   - Dark bag and extra film (if needed)
   - Flight map, Mission Request Form, and the heading on the Flight Log completed
   - Supplemental Type Certification (which includes placards a and b)
2. Before takeoff, be certain the window cover plates have been removed from both camera sections.

3. On missions that require more than one roll of film, the aircraft must land; the pod is dismounted; and a new roll of film is installed. Changing the film must be performed in the dark bag; therefore, all needed items (see Camera loading/downloading should be on the airplane during the flight. When the mission uses only one camera in the pod it is possible to avoid the problem of loading film in the field by having previously loaded another camera. Now, simply exchanging cameras when the first is exhausted allows the mission to proceed with a minimum of disruption.

4. For proper installation of the pod, the bottom of aircraft must be free of antennas and other protruding equipment from approximately the wing strut to six inches aft of the main gear.

5. At the last moment before strapping the pod in place on the aircraft, recheck the exposure conditions for the target area, and reset the f-stop if necessary. There is no way to reach the f-stop ring once the pod is mounted. It is necessary, therefore, to anticipate lighting conditions in the target area at the expected time of arrival over the target. Special conditions of sky (clouds, sun angle, etc.) as well as the ground (snow, terrain shadows, etc.) should be taken into account.

6. Color infrared film is much more sensitive to shadowing by clouds on the ground target area than are natural color or B/W film. Dense shadowing may underexpose target objectives beyond recognition.

IV. FLIGHT

All of the careful mission planning and preparation will pay off during the actual flight of the mission. With the Mission Request Form and flight map on a clipboard, the flight becomes the simple process of directing the pilot to the target area.

When in the target vicinity, the proper flight line and altitude can be obtained from the flight map. After the camera is activated, the photographer must periodically refer to the flight map to assure that the proper flight line and altitude are maintained. The photographer should also be cognizant of any change in lighting conditions during the flight, and variations from those conditions of sky and ground that may differ from the pre-calculated conditions by which the f-stop setting was made. As the flight progresses, the remainder of the Flight Log is completed (the heading having been completed prior to takeoff).

V. POST FLIGHT

A. Film Processing

The majority of Enviropod missions require immediate analysis of the photography. To expedite film processing, the film may be shipped via Express Mail airport-to-airport service. The packaged film must be hand delivered to an airport postal facility for shipping. The processing organization should be notified that exposed film is in transit, the shipping number, and when and where it may be picked up. A complete Film Data Sheet (included in Exhibit E) should be placed on top of the film canister in final packaging to assist the film processor. If possible, the canister should be shipped in its original box. In a conspicuous place on the outside of the box should appear: "Unprocessed Film, DO NOT EXPOSE TO: X-Ray, Light, Heat, or Radiation."

B. Photo Indexing

It is imperative that each frame of photography be uniquely labeled (indexed) for present use and future reference. This indexing should make it possible to identify a particular frame as to mission, type (vertical or oblique), and particular frame number. If missions are identified by number, V or O indicates vertical or oblique, and each frame is numbered sequentially; the frame 23-V-143 would indicate mission number 23, vertical photograph, and frame number 143.

For ease of viewing, photographs may be cut and placed in vinyl loose-leaf protectors, size 11" X 8½" or 9". Each protector will hold four frames of photography. Labels should be placed on photos before cutting to assure that correct sequence is maintained.

The final step of indexing is to locate the actual flight line on two maps of the flight area. One flight line copy should be kept on file with the original Flight Request Form, Flight Log, etc. The other is placed in a vinyl protector and kept with the Enviropod photographs for convenient reference. On these maps, every fifth to tenth photo should be accurately located and marked on the map to construct the entire flight as it actually occurred.

To provide a comprehensive inventory of the many different Enviropod missions flown, a master index is maintained. This index should not only provide access to content of each flight, but also identify the agency that possesses the photography

VI. EMERGENCY APPLICATIONS

Because of the speed with which Enviropod photography can be obtained, many of the missions requested will be used to document emergency or

disaster situations. When emergencies happen, the time available for mission planning and preflight preparation will be shortened considerably.

The execution of an Enviropod mission with only four to six hours of preparation time requires both well-trained personnel and organization of the different Enviropod components. The particular mission may require any combination of CIR or natural color film, vertical or oblique camera angles, Cessena 172 or 182 mounting straps, and batteries that are charged. Therefore, it is imperative that each component of the system is correctly labeled. Where all cameras, mounting straps, and film are easily located and identified, it will greatly simplify assembly of the necessary configurations.

While time is the governing factor, this does not infer that any planning or execution steps can be eliminated. To insure the highest quality photography, all of the preparation steps must be taken. By combining resources, the time required to plan and prepare for the mission can be greatly reduced. This typically involves one person assemblying equipment, another planning the flight, and another person securing the use of an appropriate aircraft. Many times the bottle neck in this procedure is availability of aircraft. Fortunately, many of the agencies requesting emergency photography will have their own aircraft, or at least access to aircraft.

VII. CONCLUSION

The high quality low cost photography produced by the EPA Enviropod makes it a very attractive system for aerial reconnaissance and documentation. In this handbook, it has been our aim to present a sound procedural basis that will provide the manager of the system with

fundamental knowledge necessary for the efficient operation of the camera system. As with any tool, the more Enviropod is used, the more proficient the operator will become. If the basic sequence of steps presented in this handbook are adhered to, maximum utilization of Enviropod should be realized.

EXHIBIT A

Federal Aviation Administration "Supplemental Type Certificate" for the Enviropod camera system.

Department of Transportation — Federal Aviation Administration

Supplemental Type Certificate

Number SA146GL

This certificate, issued to Air Force Wright Aeronautical Laboratories
AFWAL/AARF
Wright-Patterson AFB, Ohio 45433

certifies that the change in the type design for the following product with the limitations and conditions therefor as specified hereon meets the airworthiness requirements of Part 3 of the Civil Air Regulations. (See T.C. Data Sheet No. 3A12 for complete certification basis.)

Original Product — Type Certificate Number: 3A12
Make: Cessna
Model: 172M, N

Description of Type Design Change:

1. Manufacture according to List of Drawings - EPA Portable Enviro Pod, Revision K dated December 27, 1982.
2. Install the EPA Pod according to:
   a. "EPA Pod Installation", Drawing Number DA-75-D-037 (3 sheets) Sht. 1, Revision C; Sht. 2, Revision D; Sht. 3, Revision B, and;
   b. "Descriptive Installation Data for Portable Camera Pod on Cessna 172", Report Number 7402-75D, Revision I dated December 27, 1982.

Limitations and Conditions:

1. The Installation of this STC may require the disconnection of installed aircraft equipment, components of which may be located on the fuselage bottom or sides. Any such equipment, that must be disconnected, that would introduce any adverse effect upon the airworthiness of the aircraft shall be reason to deny the installation of this STC.

(See Continuation Sheet, Page 3 of 3).

This certificate and the supporting data which is the basis for approval shall remain in effect until surrendered, suspended, revoked, or a termination date is otherwise established by the Administrator of the Federal Aviation Administration.

Date of application: February 20, 1975
Date of issuance: January 19, 1977

Date issued:
Date amended: See Sheet 3

By direction of the Administrator

W. F. Horn (Signature)
Manager, Chicago Aircraft Certification
Office, ACE-115C, FAA Central Region
(Title)

Any alteration of this certificate is punishable by a fine of not exceeding $1,000, or imprisonment not exceeding 3 years, or both.

This certificate may be transferred in accordance with FAR 21.47

FAA Form 8110-2 (10-68)

Department of Transportation—Federal Aviation Administration

Supplemental Type Certificate

(Continuation Sheet)

Number SA146GL

Date of Application: February 20, 1975

Date of Issuance: January 19, 1977

Date Amended: 12/5/77; 12/11/78; 5/21/79; 7/18/79; 12/10/79; 11/3/81; 9/23/82; 3/3/83

Limitations and Conditions: (Continued:

2. The compatibility of this modification with other previously approved modifications must be determined by the installer.

3. When this STC is installed, the aircraft shall be operated in DAY/NIGHT VFR conditions only.

4. Placards: The following placards shall be installed in full view of the pilot when this STC is installed:

   a. Never exceed 160 mph (139 Kts) with sensor pod installed,

   b. Normal category only with Enviro-Pod installed.

      Max. Weight: 2227 Pounds
      C.G. Range: (+37.8) to (+45.0) at 2227 Pounds
      (+35.0) to (+45.0) at 1950 Pounds or Less
      Straight line variation between points given.

      The combined weight of the empty aircraft, enviro-pod and occupants may not exceed 2083 lbs.

      Note: Placards are removed from the airplane when this STC installation is removed.

5. The only equipment approved, for installation within the EPA Pod, are those identified in the Descriptive Installation Data Report identified under "Description of Type Design Change". Any other pod-installed equipment are subject to Limitation 2 listed above.

WPAFB, Ohio

30 October 1975

FAA
APPROVED
MAR 3 1983
CHICAGO AIRCRAFT
CERTIFICATION OFFICE
CENTRAL REGION

LIST OF DRAWINGS
EPA PORTABLE ENVIRO POD

FLYING HARDWARE

DWG. NO.	REV.	DATE	TITLE
DA-75-B-011	C	6/4/82	Camera Control, (Intervalometer) EPA Enviro-Pod
DA-75-D-026(1)	E	9/7/82	Aft Section, EPA Pod B Assembly
DA-75-D-026(2)	-	9/30/76	Aft Section "B" Assembly Details
DA-75-D-027	D	4/1/79	Side Panel, Aft Section B EPA Pod
DA-75-C-028	D	2/1/79	Strap Attachment & Hinges for EPA Pod
DA-75-D-029	D	4/1/79	Bottom Panel, Aft Section B, EPA Pod
DA-75-D-030	D	4/1/79	Window Frame & Glass, EPA Pod
DA-75-D-031	E	10/3/80	Details, EPA Pod
DA-75-D-032	E	4/1/79	Battery Shelf & Hold Down Assy, Aft Section B
DA-75-D-033	F	12/7/82	Front Section A Assembly
DA-75-D-034	E	2/28/80	Side & Bottom Panel EPA Pod, Forward Section A
DA-75-D-035	E	10/3/80	Bracket & Battery Shelf, Forward Section A
DA-75-D-036(1)	D	2/6/81	Straps & Seat Rail Clamps, EPA
DA-75-D-036(2)	-	3/19/80	Straps for Cessna 182, EPA
DA-75-D-037(1)	C	4/1/79	EPA Pod Installation
DA-75-D-037(2)	D	2/6/81	EPA Pod Installation, Configuration I
DA-75-D-037(3)	B	4/1/79	EPA Pod Installation, Configuration II
DA-75-D-039	D	4/1/79	Side Panel, Aft Section C, EPA Pod
DA-75-D-040	B	9/30/76	Bottom Panel, Aft Section C, EPA Pod
DA-75-D-041	F	6/19/80	Aft Section C, Assembly
DA-75-D-042	F	2/28/80	Details, EPA Pod
DA-75-D-043	E	4/1/79	Details, EPA Pod
DA-75-D-044	C	7/13/78	Bulkhead, Section C & Corner Gusset, all Sections
DA-75-D-046	B	11/14/78	Control Box, EPA Pod
DA-75-D-047	E	8/18/82	Electrical Harness for KA-55A
DA-76-E-042	A	4/5/79	Placards for Cessna 172

LIST OF DRAWINGS
(Continuation Sheet)

FLYING HARDWARE

DWG. NO.	REV.	DATE	TITLE
DA-78-B-014		11/16/78	P.C. Board for Camera Control
A-78-D-032		9/26/78	Control Box, EPA Pod
DA-80-D-012		6/19/80	Mounting Bracket, Perkin Elmer 2-18
A-82-D-003	A	12/29/82	Mounting Bracket for KA-69A Camera for EPA Pod A
DA-82-D-004		6/28/82	Mounting Bracket for TV Camera for EPA Pod
DA-80-B-028		8/3/82	Attachment Assembly
A-82-D-005		7/6/82	Cover, TV Control Box
DA-82-D-007		9/20/82	Universal Mounting Bracket Pod "C"
A-82-D-008		9/3/82	Battery Shelf Assembly Pod "C"
DA-82-C-011		11/3/82	Attachment Bracket, Bar, Clip
DA-82-B-012		11/15/82	Control Box Adapter-KA69A
A-82-A-015		12/7/82	Circuit Breaker Bushing And Nut
DA-82-D-016		12/15/82	Mounting Brackets KS-67 Pod "A"

EAA
APPROVED
MAR 3 1983
CHICAGO AIRCRAFT
CERTIFICATION OFFICE
CENTRAL REGION

Revision K
27 December 1983

Department of Transportation — Federal Aviation Administration

Supplemental Type Certificate

Number SA1226EA

This certificate, issued to R&D Office
U.S. Customs Service
1301 Constitution Avenue, N.W.
Washington, D. C. 20229

certifies that the change in the type design for the following product with the limitations and conditions thereof as specified hereon meets the airworthiness requirements of Part 3 *of the* Civil Air Regulations.

Original Product—Type Certificate Number: 3A13
Make: Cessna
Model: 182P and Q

Description of Type Design Change:
Installation of EPA Portable Enviro Pod in accordance with the data listed in Howard Aircraft, Inc., "Installation Drawing List for EPA Enviro Pod on Cessna 182P and Q airplanes" dated March 26, 1981, and contained in Howard Aircraft, Inc. Descriptive Installation Data for Portable Camera Pod on Cessna 182" Revision D, dated March 25, 1981.

Limitations and Conditions:
1. U.S. Customs Service Airplane Flight Manual Supplemental No. 80-D, FAA approved April 2, 1981, and Placard A specified therein is required with this installation.
2. This approval should not be incorporated in any aircraft of these specific models on which other approved modifications are incorporated, unless it is determined that the interrelationship between this change and any of those previously incorporated approved modifications will not introduce any adverse effect upon the airworthiness of the aircraft.

This certificate and the supporting data which is the basis for approval shall remain in effect until surrendered, suspended, revoked, or a termination date is otherwise established by the Administrator of the Federal Aviation Administration.

Date of application: December 20, 1980
Date issued:
Date of issuance: April 2, 1981
Date amended:

By direction of the Administrator

Raymond J. Borowski
(Signature)
RAYMOND J. BOROWSKI
Chief, Engineering and Manufacturing Branch
(Title)

Any alteration of this certificate is punishable by a fine of not exceeding $1,000, or imprisonment not exceeding 3 years, or both.

This certificate may be transferred in accordance with FAR 21.47.

FAA Form 8110-2 (10-68)

EXHIBIT B

Mission Planning Forms and Tables

ENVIRO-POD AERIAL PHOTOGRAPHIC SYSTEM
MISSION REQUEST FORM

GENERAL INFORMATION Date: _____

Requesting Organization: _____

Address: _____

Technical Contact Person: _____

General Project Description: _____

PROPOSED ENVIRO-POD MISSION

1. Project Location. Attach USGS map (1:24,000 or 1:100,000), or xerox copy of map, marking proposed flight area. Brief description of target area: _____

_____

2. Project Timing. The photo mission is to be flown between _____ (month-day-year) and _____ (month-day-year). Preferred date: _____ (month-day-year)

Preferred solar angle (low angle for shadow, sun overhead for minimal shadow): _____

Special timing considerations (i.e., high water stage, after leaf drop, etc.):

_____

3. Photography Specifications (check applicable blanks).

Vertical _____ Natural Color _____ Color Infrared _____

Oblique _____ Natural Color _____ Color Infrared _____

For vertical photos only, specify type of coverage required:

Monoscopic ____ Stereoscopic ____

Desired nominal vertical photo scale: 1:_____ or 1" = _____ feet.

4. Special Instructions. Please provide any additional information about the anticipated applications of the requested photography which may aid in flight planning. Also, note any deadlines for photography delivery.

_____

_____

_____

_____

5. It is often encouraged that an individual from your organization accompany the pilot on photo missions to aid in obtaining target photography and to reduce costs. Please indicate who may be available, if desired, to participate in this mission.

_____

6. Organizations interested in mission cost sharing: _____

Organizations contacted but not interested: _____

Mission Planning Data and Flight Calculations

AGL	Vertical Camera						Oblique Cam.
	Scale	Lateral Coverage	Forward Coverage 20%	Forward Coverage 60%	Cycle Time 20%	Cycle Time 60%	Cycle Time 50% overlap
500	1:1900	.40	.05	.03	1.8	1.0	2.7
1000	3800	.80	.11	.05	3.7	1.9	5.4
1500	5700	1.20	.16	.08	5.6	2.8	8.1
2000	7600	1.63	.22	.11	7.4	3.8	10 8
2500	9500	2.02	.27	.14	9.3	4.8	13.5
3000	11400	2.43	.33	.16	11.2	5.7	16.2
3500	13300	2.84	.38	.19	13.0	6.6	18.8
4000	15200	3.25	.44	.22	14.9	7.6	21.5
4500	17100	3.66	.49	.25	16.8	8.5	24.2
5000	19000	4.07	.55	.27	17.7	9.5	26.9
5500	20900	4.48	.60	.30	20.6	10.4	29.6
6000	22800	4.89	.66	.33	22.5	11.4	32.3
6500	24700	5.30	.71	.35	24.4	12.3	35.0
7000	26600	5.71	.77	.38	26.3	13.3	37.7

NOTE: all distance (coverage) is given in miles, all cycle times are in seconds. Cycle time is calculated assuming a ground speed of 90 knots.

Calculation of film needed for a given length of flight:

$$\frac{(\text{LENGTH OF FLIGHT})}{(\text{FORWARD COVERAGE})(1.5)} = (\text{feet of film required})$$

Scale	Feet per inch	Inches per mile	Miles per inch	Acres per square inch	Square inches per acre	Square miles per square inch
1:500	41.667	126.720	0.008	0.0399	25.0906	0.00006
1:600	50.000	105.600	0.009	0.0574	17.4240	0.00009
1:800	66.667	79.200	0.013	0.1020	9.8010	0.00016
1:1000	83.333	63.360	0.016	0.1594	6.2726	0.00025
1:1200	100.000	52.800	0.019	0.2296	4.3550	0.00036
1:1500	125.000	42.240	0.024	0.3587	2.7878	0.00056
1:2000	166.667	31.680	0.032	0.6377	1.5682	0.00100
1:2400	200.000	26.400	0.038	0.9183	1.0890	0.00143
1:2500	208.333	25.344	0.039	0.9964	1.0036	0.00155
1:3000	250.000	21.120	0.047	1.4348	0.6970	0.00224
1:3600	300.000	17.600	0.057	2.0661	0.4840	0.00323
1:4000	333.333	15.840	0.063	2.5508	0.3920	0.00398
1:4800	400.000	13.200	0.076	3.6731	0.2723	0.00574
1:5000	416.667	12.672	0.079	3.9356	0.2509	0.00624
1:5280	440.000	12.000	0.0833	4.4444	0.225	0.00694
1:6000	500.000	10.560	0.095	5.7392	0.1742	0.00897
1:6500	541.667	9.748	0.103	6.7356	0.1485	0.01054
1:7000	583.333	9.051	0.110	7.8117	0.1280	0.01219
1:7200	600.000	8.800	0.114	8.2645	0.1210	0.01291
1:7920	660.000	8.000	0.125	10.0000	0.1000	0.01563
1:8000	666.667	7.920	0.126	10.2030	0.0980	0.01596
1:8400	700.000	7.543	0.133	11.2489	0.0889	0.01758
1:9000	750.000	7.040	0.142	12.9132	0.0774	0.02018
1:9600	800.000	6.600	0.152	14.6924	0.0681	0.02296
1:10000	833.333	6.336	0.158	15.9423	0.0627	0.02489
1:10800	900.000	5.867	0.170	18.5950	0.0538	0.02905
1:12000	1000.000	5.280	0.189	22.9568	0.0436	0.03587
1:13200	1100.000	4.800	0.208	27.7778	0.0360	0.04340
1:14400	1200.000	4.400	0.227	33.0579	0.0303	0.05165
1:15000	1250.000	4.224	0.237	35.8701	0.0279	0.05605
1:15600	1300.000	4.062	0.246	38.7971	0.0258	0.06062
1:15840	1320.000	4.000	0.250	40.0000	0.0250	0.06250
1:16000	1333.333	3.960	0.253	40.8122	0.0245	0.06374
1:16800	1400.000	3.771	0.265	44.9954	0.0222	0.07031
1:18000	1500.000	3.520	0.284	51.6529	0.0194	0.08071
1:19000	1583.333	3.335	0.300	57.5515	0.0174	0.08989
1:19200	1600.000	3.300	0.303	58.7695	0.0170	0.09183
1:20000	1666.667	3.168	0.316	63.7690	0.0157	0.09968
1:20400	1700.000	3.106	0.322	66.3453	0.0151	0.10366
1:21120	1760.000	3.000	0.333	71.1111	0.0141	0.11111
1:21600	1800.000	2.933	0.341	74.3802	0.0134	0.11622
1:22200	1850.000	2.854	0.350	78.5698	0.0127	0.12277
1:22800	1900.000	2.779	0.360	82.8742	0.0121	0.12949
1:24000	2000.000	2.640	0.379	91.8274	0.0109	0.14348
1:25000	2083.333	2.534	0.395	99.6391	0.0100	0.15564
1:31680	2640.000	2.000	0.500	160.0000	0.0063	0.25000
1:36000	3000.000	1.760	0.568	206.6116	0.0048	0.32283
1:40000	3333.333	1.584	0.631	255.0760	0.0039	0.39484
1:48000	4000.000	1.320	0.758	367.3095	0.0027	0.57392
1:50000	4166.667	1.267	0.789	393.5563	0.0025	0.62284
1:60000	5000.000	1.056	0.947	573.9210	0.0017	0.89575
1:62500	5208.333	1.014	0.936	622.7442	0.0016	0.97291
1:63360	5280.000	1.000	1.000	640.0000	0.0016	1.00000
1:70000	5833.333	0.905	1.105	781.1703	0.0013	1.22044
1:95000	8000.000	0.660	1.515	1469.2378	0.0007	2.29568
1:120000	10000.000	0.528	1.894	2295.6841	0.0004	3.58700
1:125000	10416.667	0.507	1.973	2490.9800	0.0004	3.89165
1:126720	10560.000	0.500	2.000	2560.0000	0.0004	4.00000
1:144000	12000.000	0.440	2.273	3305.7851	0.0003	5.16529
1:250000	20833.333	0.253	3.946	9963.9070	0.0001	15.56811
Formulas	$\frac{\text{Scale}}{12}$	$\frac{63360}{\text{Scale}}$	$\frac{\text{Scale}}{63360}$	$\frac{(\text{Scale})}{43560\times144}$	$\frac{43560\times144}{(\text{Scale})}$	$\frac{(\text{Ft. per In.})}{(5280)}$

ENVIROPOD AERIAL PHOTOGRAPHIC SYSTEM FLIGHT LOG

PROJECT LOCATOR _____

CLIENT ORGANIZATION _____

FLIGHT DATE (DAY, MONTH, YEAR) _____

PILOT _____

PHOTOGRAPHER _____

AIRCRAFT NUMBER _____

ENVIROPOD SERIAL NUMBER _____

CAMERA SERIAL NUMBER _____ OH _____ VV _____

FILM TYPE _____

FILTER TYPE _____

f-STOP _____

REMARKS _____

FLIGHT LINE NUMBER	ALTITUDE	HEADING	TIME START	VV FRAME COUNT		OH FRAME COUNT		TIME STOP	CONDITIONS, (WEATHER, AIRCRAFT ATTITUDE, EQUIPMENT MALFUNCTION, OTHE
				START	STOP	START	STOP		

ENVIROPOD MISSION COST ESTIMATING*

FIXED COSTS OF PHOTO ACQUISITION

Film, per 200 foot roll (300 frames)	NC	$225
	NR	$266
Processing, per 200 foot roll		$200
Mission planning, preparation and interaction with requesting agency (3-9 person hours)		$45-120
Load, set, test and download camera(s); install and remove pad; trips to and from airport; prepare for mailing (7 ph)		$105
Postage to Las Vegas for processing		
UPS pickup		$ 6
Airport to airport mailing, incl. two roundtrips (4 hrs)		$ 66
Handling (2 ph)		$ 30

VARIABLE COSTS OF PHOTO ACQUISITION

Indexing, labeling, and binding per roll: material and labor	$155
OR indexing, but leaving on roll: material and labor	$ 75
Airplane and pilot's time (assumed 2 hour flight)	$180
Camera operator time (assumed 2 hour flight)	$ 30

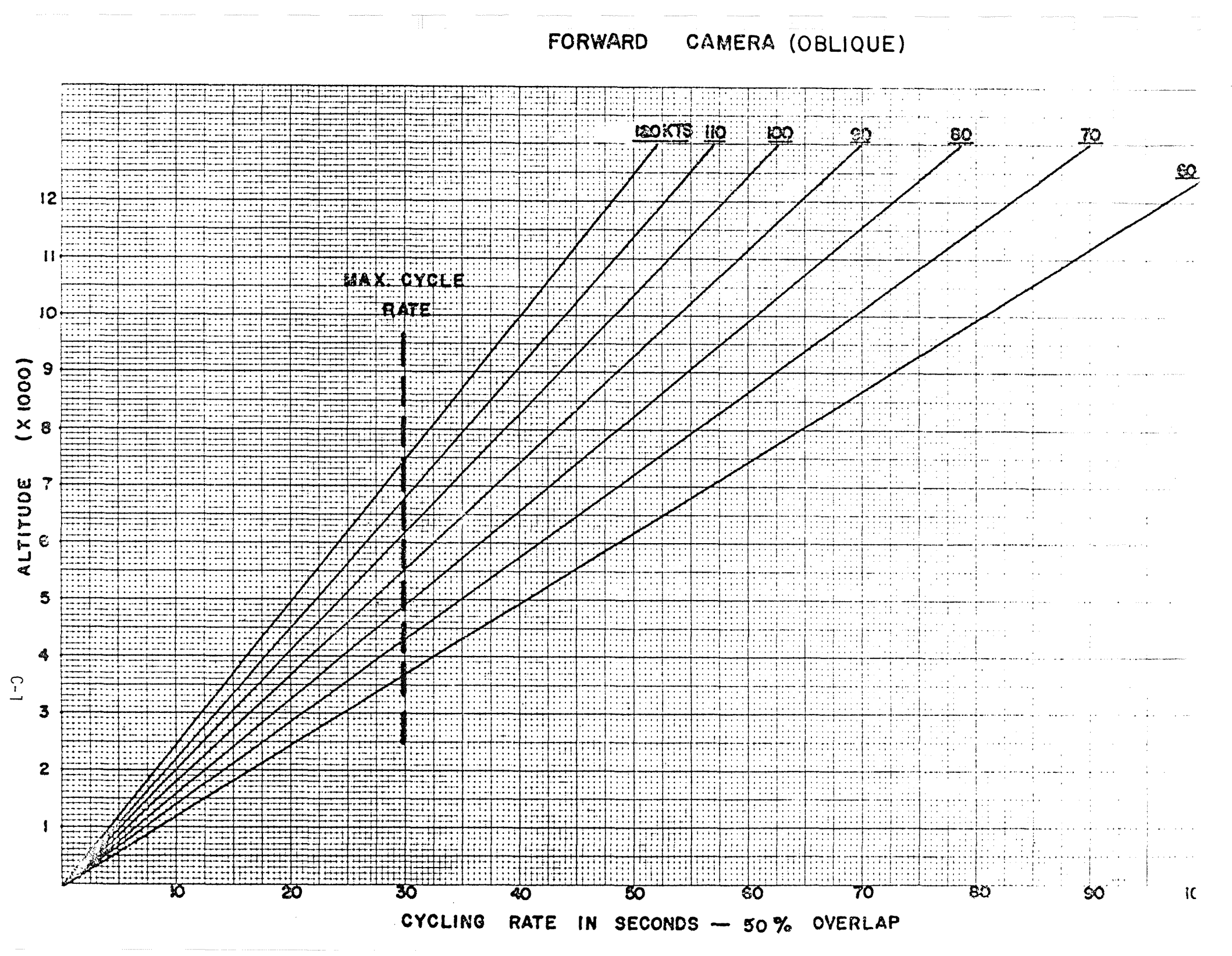
INTERPRETATION AND MAPPING

Highly variable, negotiable

* Labor costs based on $15/hour: trained graduate plus benefits, under supervision

EXHIBIT C

Mission Planning Elements (graphs depicting intervalometer, forward and lateral overlap, etc.)


FORWARD CAMERA (OBLIQUE)
120 KTS
110
100
90
80
70
60
MAX. CYCLE RATE
ALTITUDE (X 1000)
12
11
10
9
8
7
6
5
4
3
2
1
10
20
30
40
50
60
70
80
90
CYCLING RATE IN SECONDS — 50% OVERLAP

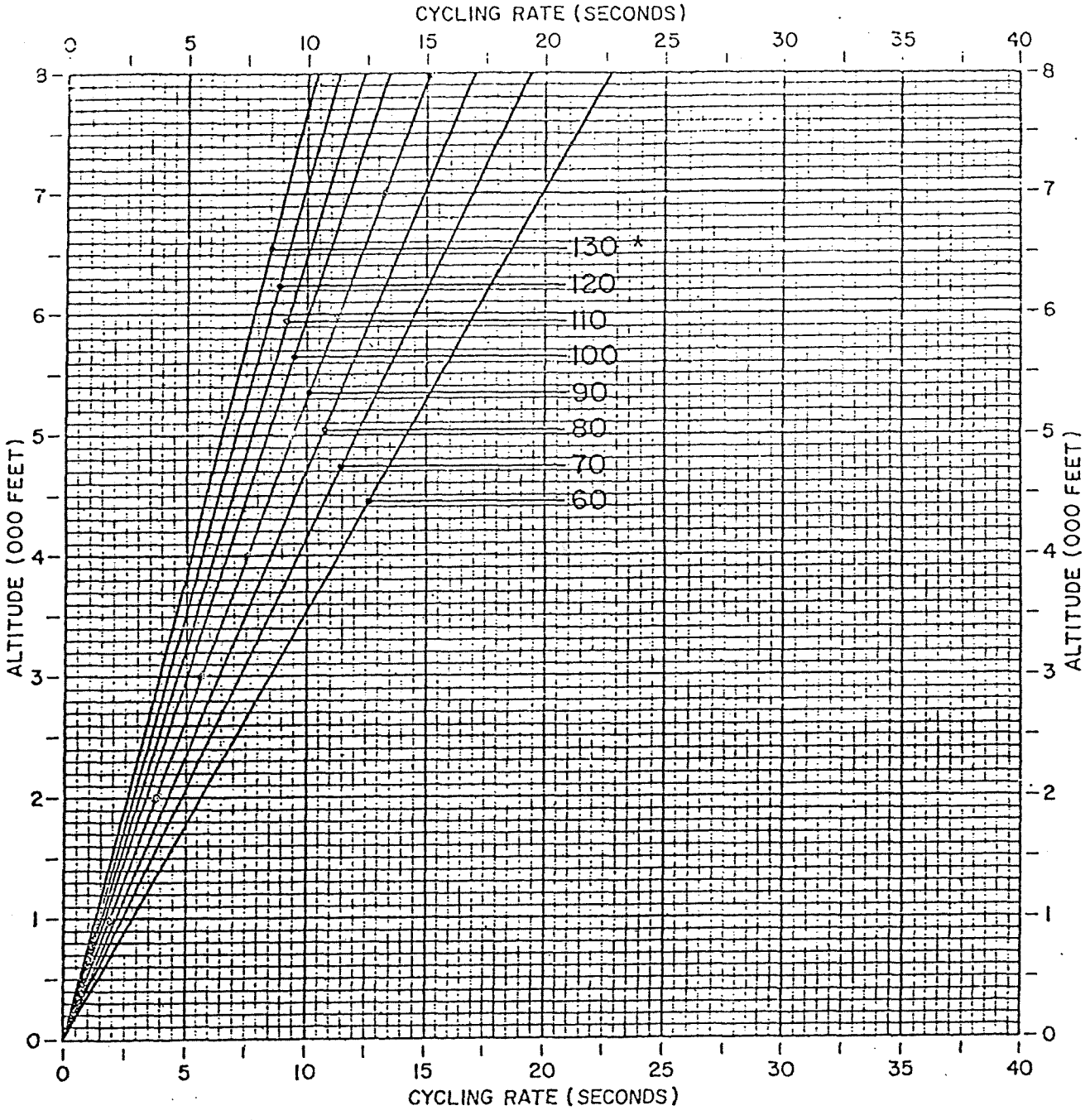


Figure 1. Intervalometer settings for sixty percent overlap.

* groundspeed in knots (1 knot equals 1.152 miles-per-hour or 1.852 kilometers-per-hour).

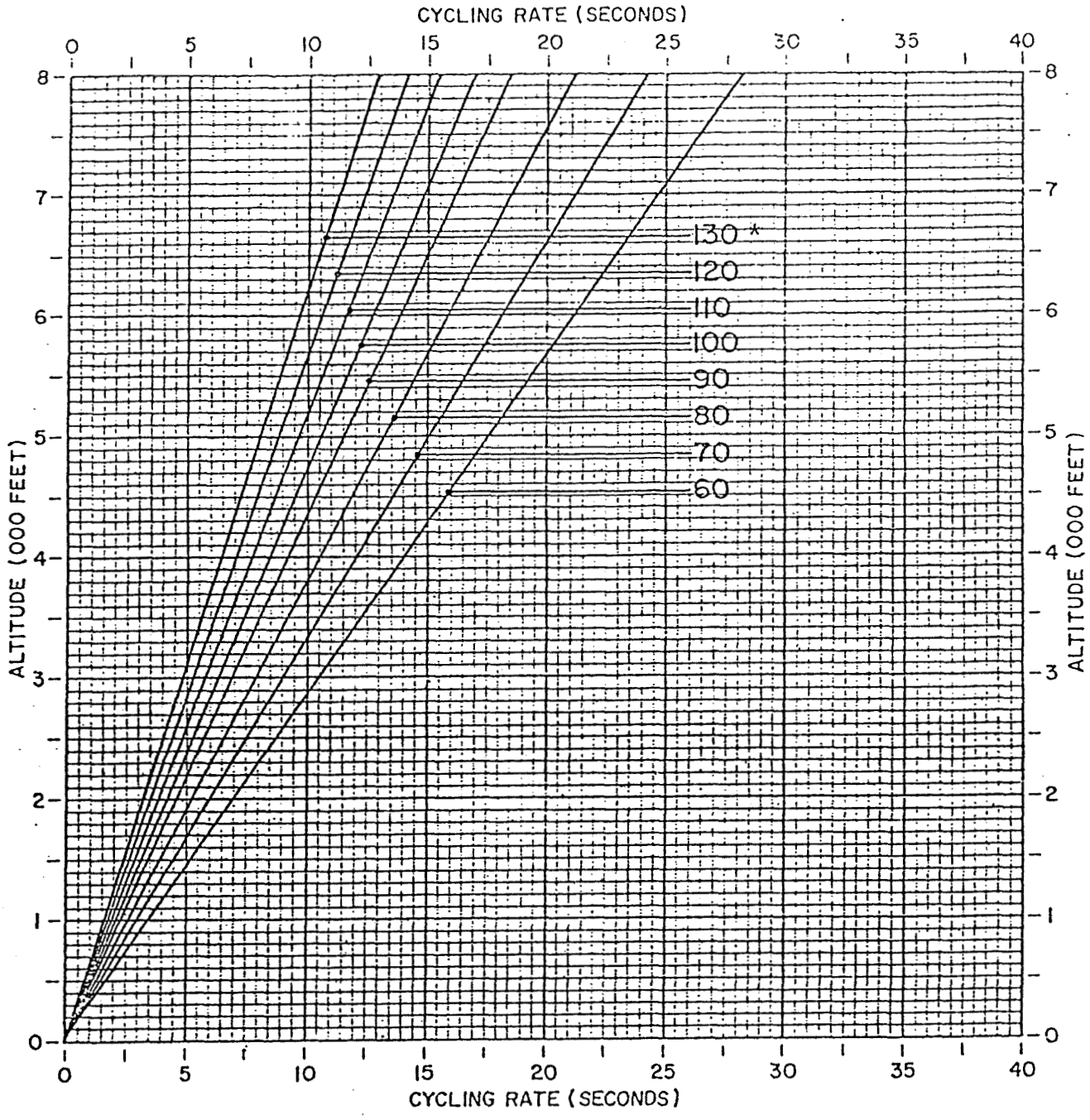


Figure 2. Intervalometer settings for fifty percent overlap.

* groundspeed in knots (1 knot equals 1.152 miles-per-hour or 1.852 kilometers-per-hour).

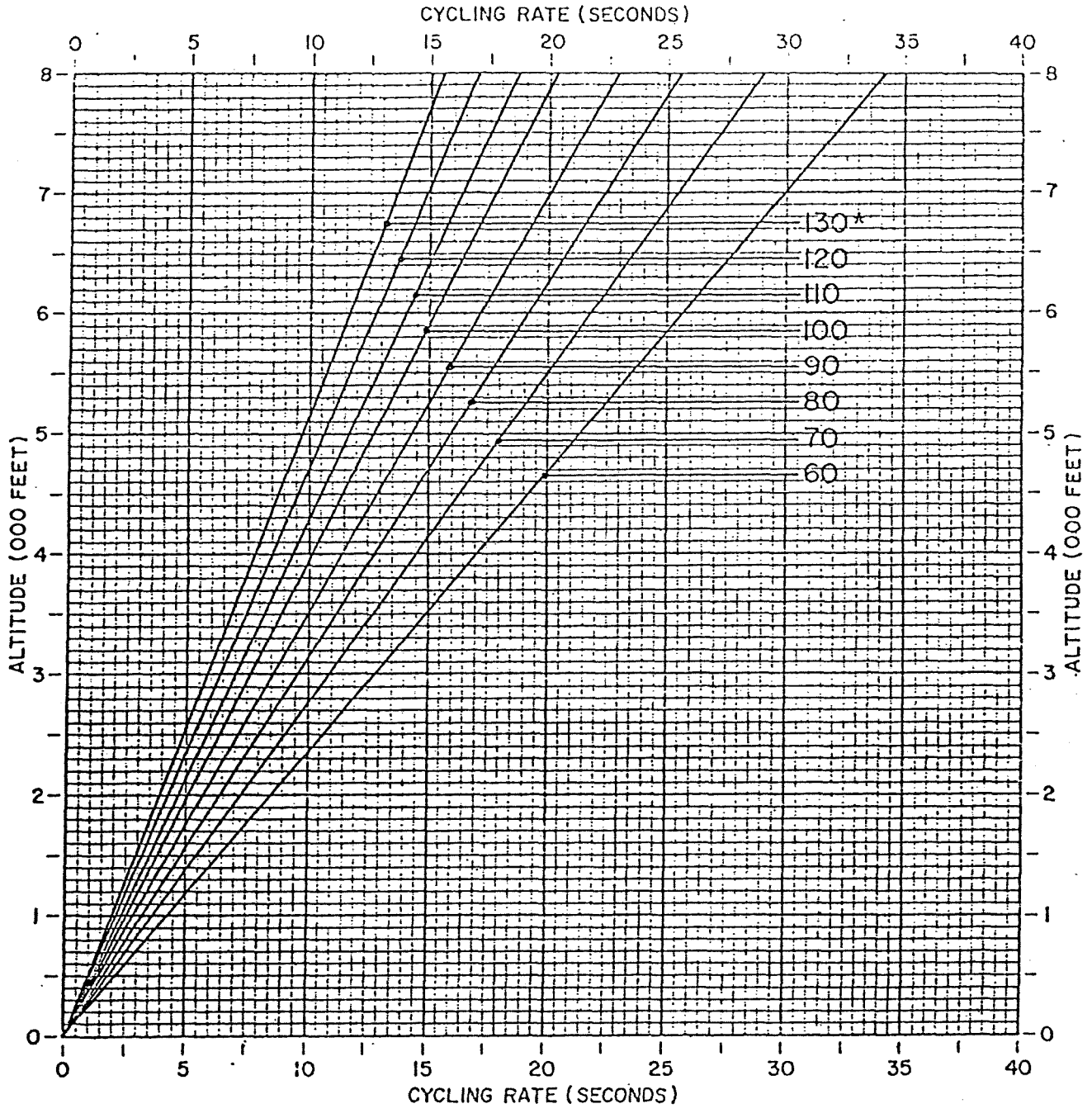


Figure 3. Intervalometer settings for forty percent overlap.

* groundspeed in knots (1 knot equals 1.152 miles-per-hour or 1.852 kilometers-per-hour).

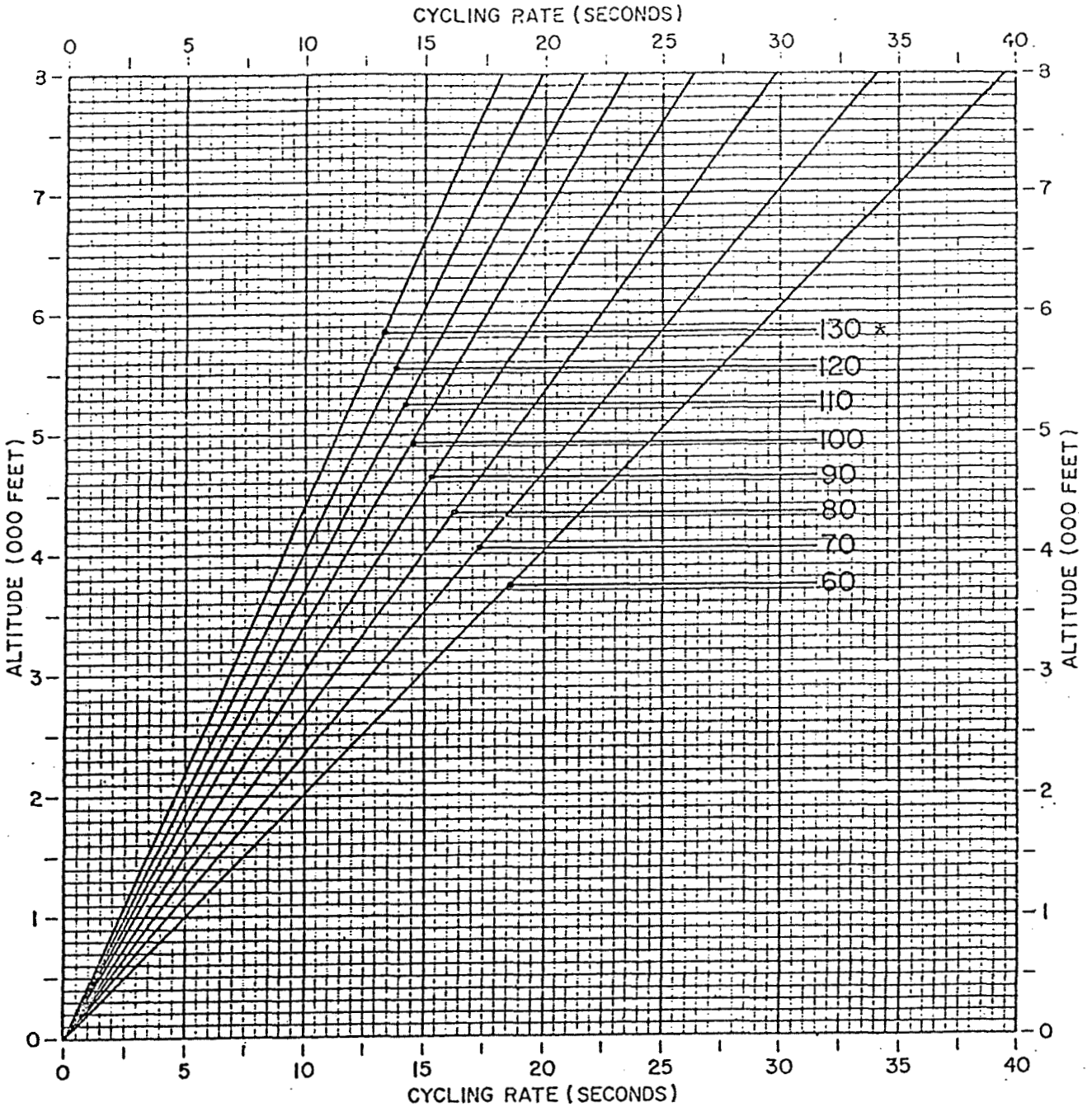


Figure 4. Intervalometer settings for thirty percent overlap.

* groundspeed in knots (1 knot equals 1.152 miles-per-hour or 1.852 kilometers-per-hour).

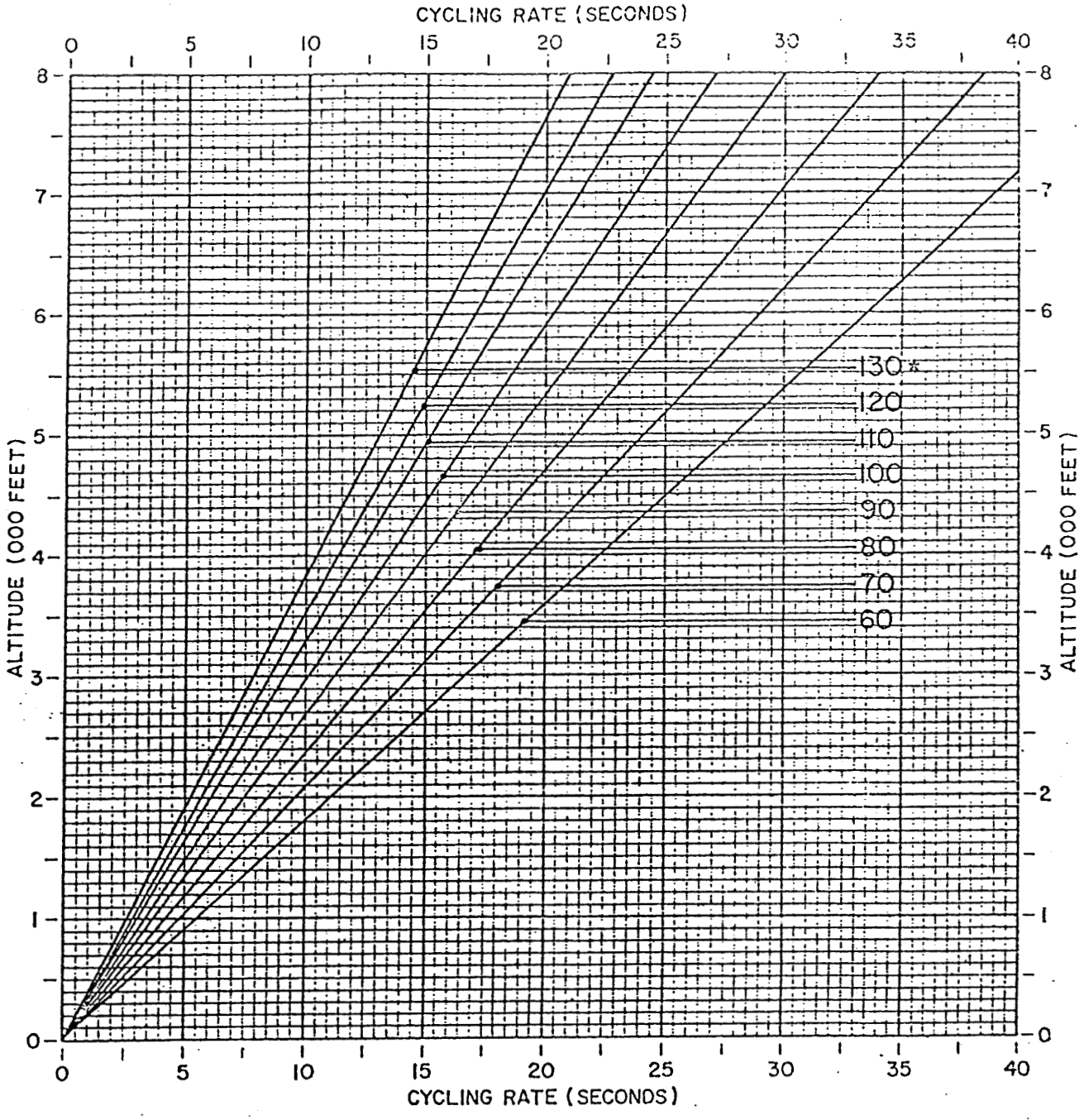


Figure 5. Intervalometer settings for twenty percent overlap.

* groundspeed in knots (1 knot equals 1.152 miles-per-hour or 1.852 kilometers-per-hour).

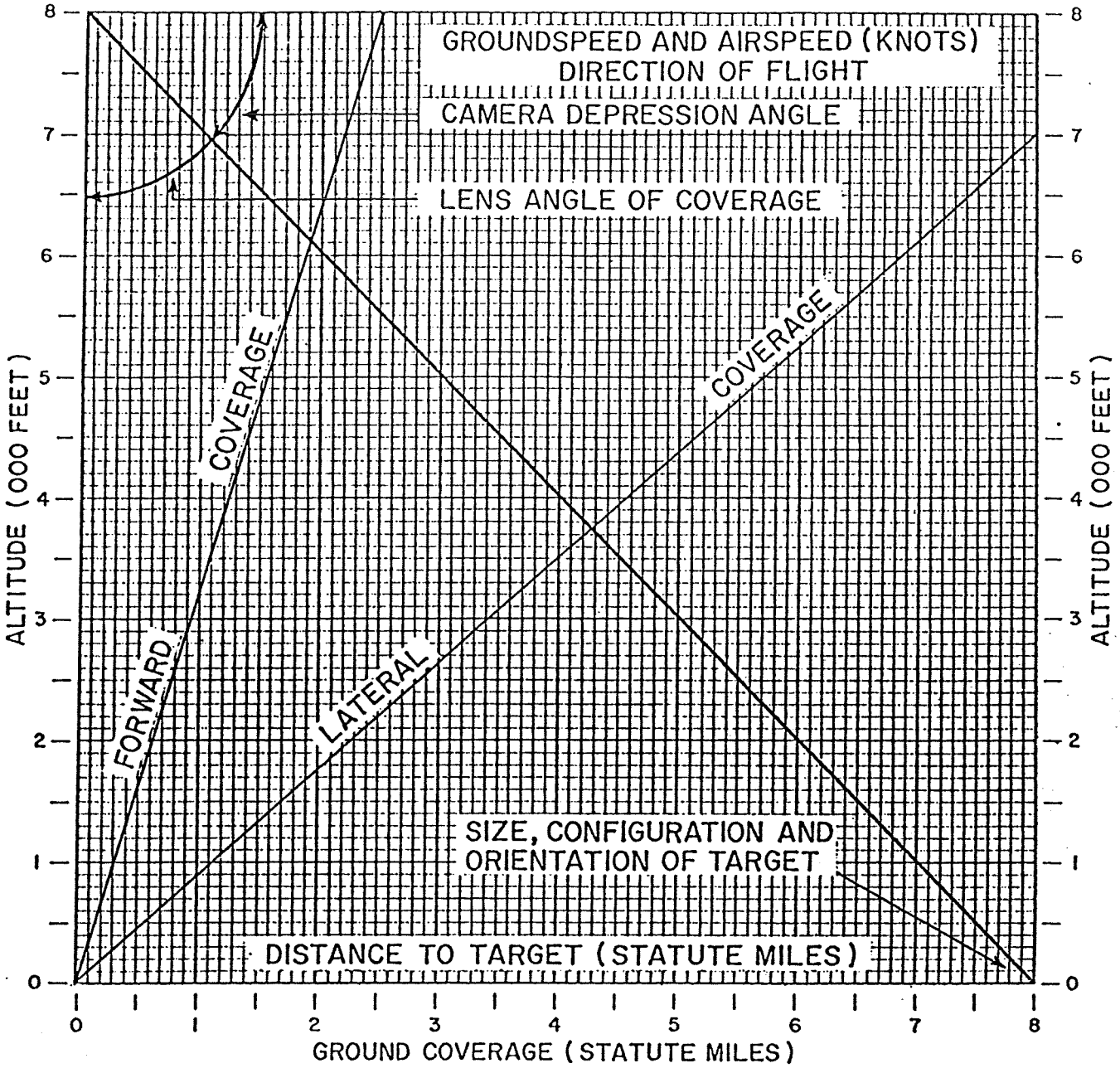


Figure 6. Mission planning elements for oblique aerial photographs. Forward coverage, lateral coverage, altitude and ground coverage in statute miles are quantitatively shown on the nomogram and can be used calculation. All other elements are descriptive and should not be used for calculation.

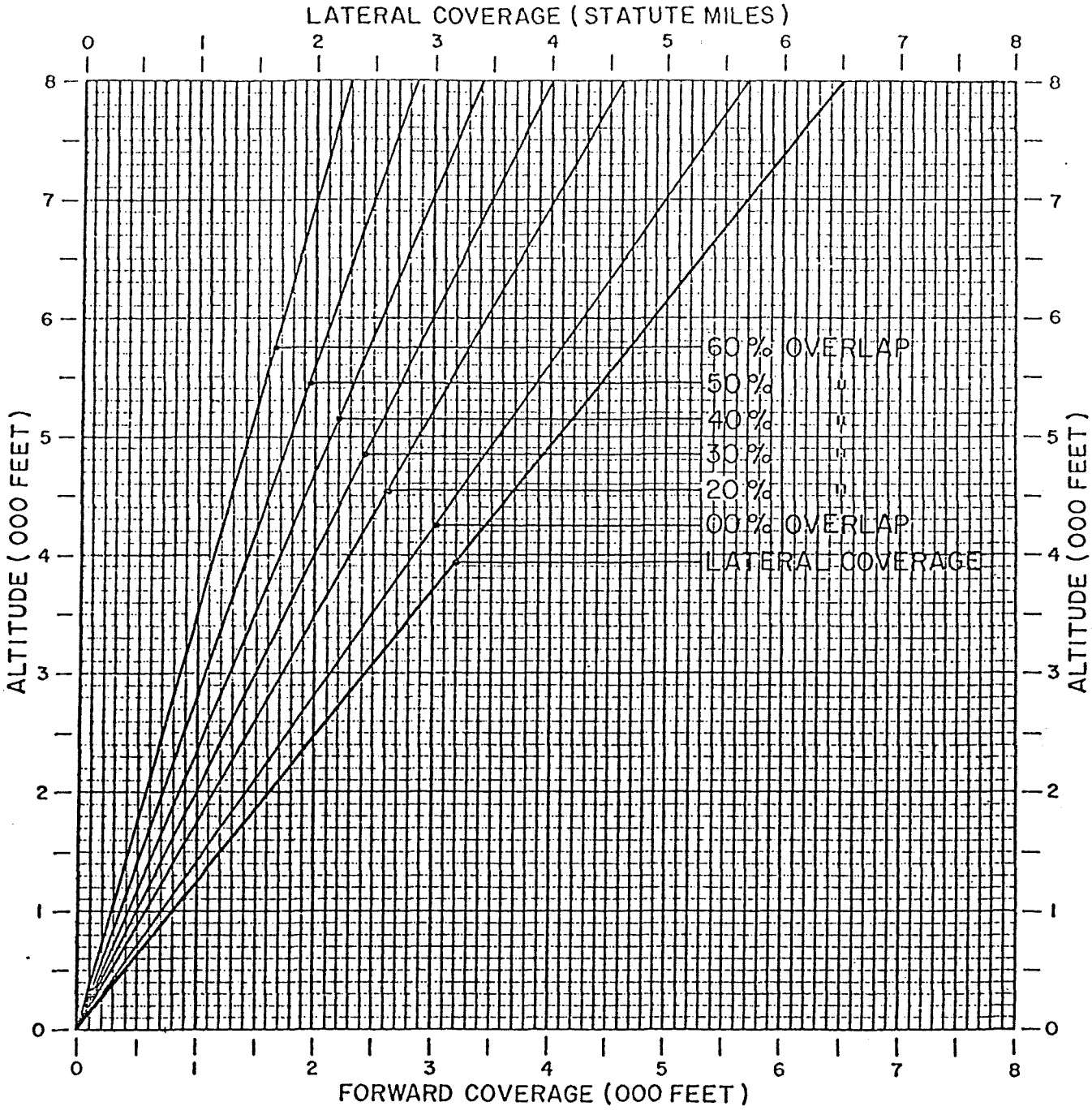


Figure 7. Vertical camera aerial photographic coverage planning elements. Lateral coverage only is to be calculated from the top of the nomogram. Forward coverage only is to be calculated from the bottom of the nomogram.

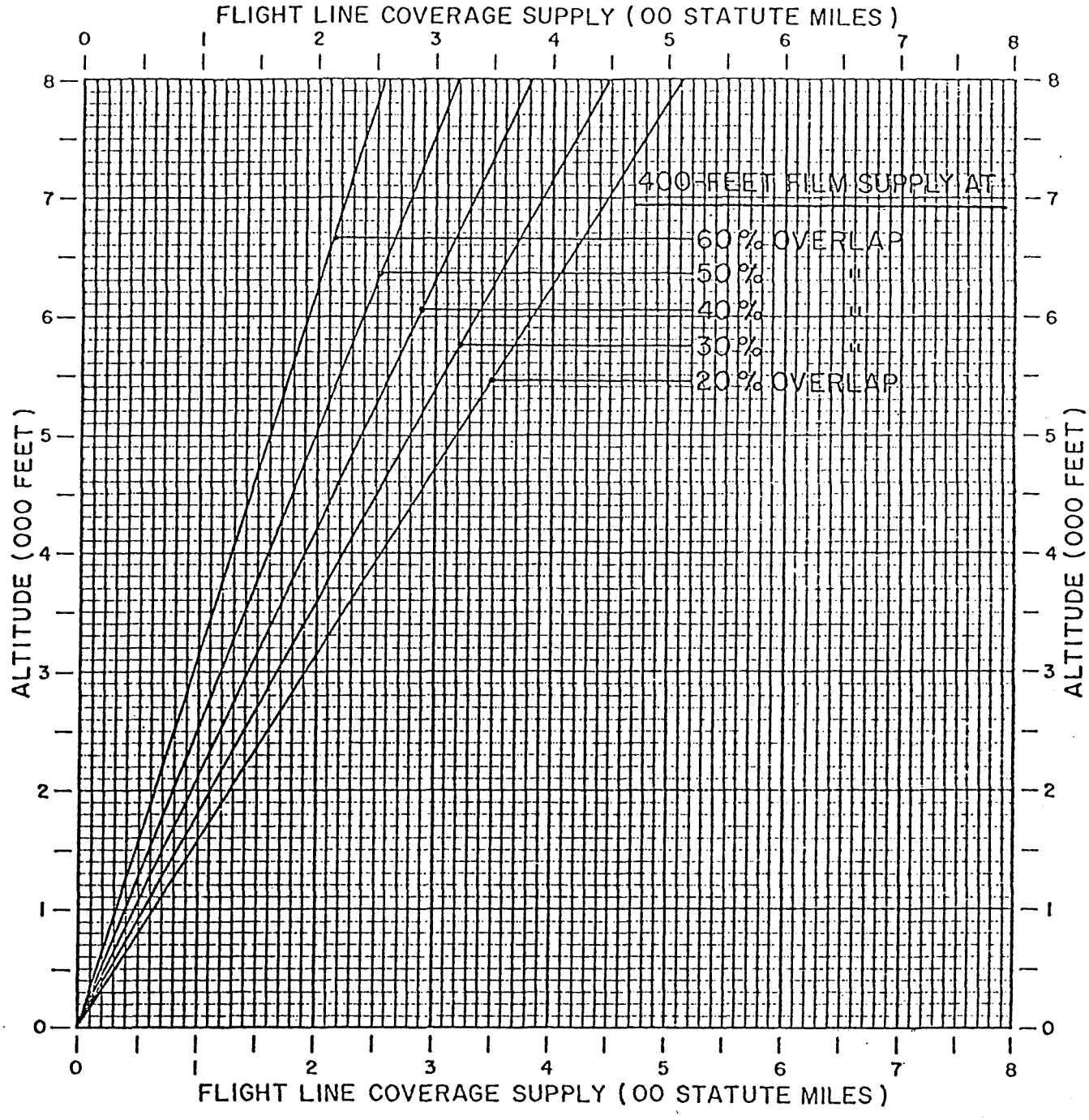


Figure 8. Film load and film supply mission planning elements for vertical aerial camera.

EXHIBIT D

Hewlett-Packard Program for HP 41C (program for mission planning).

KEYING A PROGRAM INTO THE HP-41C

There are several things that you should keep in mind while you are keying in programs from the program listings provided in this book. The output from the HP 82143A printer provides a convenient way of listing and an easily understood method of keying in programs without showing every keystroke. This type of output is what appears in this handbook. Once you understand the procedure for keying programs in from the printed listings, you will find this method simple and fast. Here is the procedure:

1. At the end of each program listing is a listing of status information required to properly execute that program. Included is the SIZE allocation required. Before you begin keying in the program, press [XEQ] [ALPHA] SIZE [ALPHA] and specify the allocation (three digits; e.g., 10 should be specified as 010).

   Also included in the status information is the display format and status of flags important to the program. To ensure proper execution, check to see that the display status of the HP-41C is set as specified and check to see that all applicable flags are set or clear as specified.

2. Set the HP-41C to PRGM mode (press the [PRGM] key) and press [■] [GTO] [.] [.] to prepare the calculator for the new program.

3. Begin keying in the program. Following is a list of hints that will help you when you key in your programs from the program listings in this handbook.

   a. When you see " (quote marks) around a character or group of characters in the program listing, those characters are ALPHA. To key them in, simply press [ALPHA], key in the characters, then press [ALPHA] again. So "SAMPLE" would be keyed in as [ALPHA] "SAMPLE" [ALPHA].

   b. The diamond in front of each LBL instruction is only a visual aid to help you locate labels in the program listings. When you key in a program, ignore the diamond.

   c. The printer indication of divide sign is /. When you see / in the program listing, press [÷].

   d. The printer indication of the multiply sign is ⋇. When you see ⋇ in the program listing, press [×].

   e. The ⊢ character in the program listing is an indication of the [APPEND] function. When you see ⊢, press [■] [APPEND] in ALPHA mode (press [■] and the K key).

   f. All operations requiring register addresses accept those addresses in these forms:

      nn (a two-digit number)
      IND nn (INDIRECT: [■], followed fy a two-digit number)
      X, Y, Z, T, or L (a STACK address: [.] followed by X, Y, Z, T, or L)
      IND X, Y, Z, T or L (INDIRECT stack: [■] [.] followed by X, Y, Z, T, or L)

      Indirect addresses are specified by pressing [■] and then the indirect address. Stack addresses are specified by pressing [.] followed by X, Y, Z, T, or L. Indirect stack addresses are specified by pressing [■] [.] and X, Y, Z, T, or L.

Printer Listing	Keystrokes	Display
01◆LBL "SAMPLE"	[■] [LBL] [ALPHA] SAMPLE [ALPHA]	*01 LBL"SAMPLE*
02 "THIS IS A "	[ALPHA] *THIS IS A* [ALPHA]	*02"THIS IS A*
03 "⊢SAMPLE"	[ALPHA] [■] [APPEND] SAMPLE	*03" ⊢ SAMPLE*
04 AVIEW	[■] AVIEW [ALPHA]	*04 AVIEW*
05 6	6	*05 6*
06 ENTER↑	[ENTER↑]	*06 ENTER ↑*
07 -2	2 [CHS]	*07 -2*
08 /	[÷]	*08 /*
09 ABS	[XEQ] [ALPHA] ABS [ALPHA]	*09 ABS*
10 STO IND L	[STO] [■] [.] L	*10 STO IND L*
11 "R3="	[ALPHA] R3= [■] [ARCL] 03	*11"R3=*
12 ARCL 03	[■] [AVIEW]	*12 ARCL 03*
13 AVIEW	[ALPHA]	*13 AVIEW*
14 RTN	[■] [RTN]	*14 RTN*

User Instructions

SIZE: 008

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Load program			
2	Begin execution		(EXQ) POD	VERT CAM Y/N
	For vertical camera	Y	(R/S)	
	go to step 3			
	For oblique camera	N	(R/S)	
	go to step 5			
3	Planning for vertical camera			STEREO Y/N
	For stereo	Y	(R/S)	AGL FT ?
	For mono	N	(R/S)	AGL FT ?
	(input AGL if known, if scale only is			
	known press (R/S) after "AGL FT ?" is	AGL	(R/S)	
	displayed, then input scale value)	or scale	(R/S)	AGL=
				SCALE 1:
			(R/S)	SPEED KNTS ?
	Input ground speed in knots	speed	(R/S)	INV=
			(R/S)	COVERAGE Y/N
	For coverage (forward and lateral)	Y	(R/S)	FOR.=
			(R/S)	LAT.=
	For no coverage	N	(R/S)	FT PLAN Y/N
	For no flight planning	N	(R/S)	STEREO Y/N
	go to step 3			
4	For flight planning	Y	(R/S)	AGL FT ?
	(when prompted for unknown variable press	AGL	(R/S)	FL DIST ?
	(R/S), the unknown is automatically calc)	or FL DIST.	(R/S)	FT OF FILM ?
		or FT FILM	(R/S)	AGL=
			(R/S)	FL DIST=
			(R/S)	FT FILM=

User Instructions

SIZE:008

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	to start flight planning again press (R/S)		(R/S)	
5	Planning for oblique camera			SPEED KNTS ?
	Input ground speed in knots	speed	(R/S)	% OVERLAP ?
	Input desired forward overlap in percent	overlap %	(R/S)	AGL ?
	(suggested overlap 40-50%)			
		AGL	(R/S)	FOR COVERAGE=
			(R/S)	LAT COVERAGE=
			(R/S)	INV=
			(R/S)	FL PLAN Y/N
	For flight planning (go to step 4)	Y	(R/S)	AGL FT ?
	For no flight planning	N	(R/S)	SPEED KNTS ?
	go to step 5			

Program Listings

```
01♦LBL "POD"
02 FIX 0
03 AON
04 "VERT ? Y/N"
05 PROMPT
06 AOFF
07 ASTO X
08 "Y"
09 ASTO Y
10 X=Y?
11 GTO 06
12 GTO 07
13♦LBL 06
14 AON
15 "VERTICAL CRM."
16 PSE
17 AOFF
18 AON
19 "STEREO ? Y/N"
20 PROMPT
21 AOFF
22 ASTO X
23 "Y"
24 ASTO Y
25 X=Y?
26 GTO 05
27 .8
28 STO 05
29 GTO 08
30♦LBL 05
31 .4
32 STO 05
33♦LBL 08
34 CF 22
35 "AGL FT ?"
36 PROMPT
37 FS? 22
38 GTO 09
39 "SCALE 1:   ?"
40 PROMPT
41 STO 07
42 .26247
43 *
44 STO 06
45 GTO 10
46♦LBL 09
47 STO 06
48 .26247
49 /
50 STO 07
51♦LBL 10
52 "AGL="
53 ARCL 06
54 "↓ FT"
55 PROMPT
56 "SCALE 1:"
57 ARCL 07
58 PROMPT
59 "SPEED KNTS ?"
60 FIX 1
61 PROMPT
62 1/X
63 RCL 05
64 *
65 RCL 06
66 *
67 .42267
68 *
69 "INV="
70 ARCL X
71 "↓ SEC"
72 PROMPT
73 FIX 0
74 AON
75 "COVERAGE Y/N"
76 PROMPT
77 AOFF
78 ASTO X
79 "Y"
80 ASTO Y
81 X=Y?
82 XEQ 11
83 .000202879
84 STO 07
85 AON
86 "FL PLAN  Y/N"
87 PROMPT
88 AOFF
89 ASTO X
90 "Y"
91 ASTO Y
92 X=Y?
93 XEQ 00
94 XEQ 06
95♦LBL 11
96 FIX 2
97 .000135253
98 RCL 06
99 *
100 RCL 05
```

Program Listings

```
101 *
102 "FOR="
103 ARCL X
104 "⊢ MI"
105 PROMPT
106 .000812313
107 RCL 06
108 *
109 "LAT="
110 ARCL X
111 "⊢ MI"
112 PROMPT
113 RTN
114*LBL 00
115 1.1
116 STO 00
117 CF 22
118 "AGL FT  ?"
119 XEQ 04
120 "FL DIST MI ?"
121 XEQ 04
122 "FT OF FILM ?"
123 XEQ 04
124 XEQ IND 04
125 GTO 12
126*LBL 04
127 PROMPT
128 STO IND 00
129 RCL 00
130 FC?C 22
131 STO 04
132 ISG 00
133 RTN
134*LBL 01
135 RCL 02
136 RCL 03
137 /
138 RCL 07
139 /
140 RCL 05
141 /
142 STO 01
143 RTN
144*LBL 02
145 RCL 01
146 RCL 03
147 *
148 RCL 07
149 *
150 RCL 05
151 *
152 STO 02
153 RTN
154*LBL 03
155 RCL 02
156 RCL 01
157 /
158 RCL 07
159 /
160 RCL 05
161 /
162 STO 03
163 RTN
164*LBL 12
165 FIX 0
166 "AGL="
167 ARCL 01
168 "⊢ FT"
169 PROMPT
170 FIX 1
171 "FL DIST="
172 ARCL 02
173 "⊢ MI"
174 PROMPT
175 FIX 0
176 "FT FILM="
177 ARCL 03
178 PROMPT
179 GTO 00
180*LBL 07
181 AON
182 "OBLIQUE CAM."
183 PSE
184 AOFF
185 "SPEED KNTS ?"
186 PROMPT
187 STO 01
188 "% OVERLAP ?"
189 PROMPT
190 100
191 /
192 CHS
193 1
194 +
195 STO 05
196 "AGL FT ?"
197 PROMPT
198 FIX 2
199 STO 00
200 .00031
```

Program Listings

```
201 *
202 RCL 05
203 *
204 "FOR VIEW="
205 ARCL X
206 "┣ MI"
207 PROMPT
208 RCL 00
209 067
210 /
211 "LAT="
212 ARCL X
213 "┣ MI"
214 PROMPT
215 RDN
216 3125
217 *
218 RCL 01
219 /
220 FIX 1
221 "IVOL AT "
222 1
223 RCL 05
224 -
225 100
226 *
227 ARCL X
228 "┣%="
229 ARCL Y
230 "┣ SEC"
231 PROMPT
232 .000465
233 STO 07
234 AON
235 "FT PLAN  Y/N"
236 PROMPT
237 AOFF
238 ASTO X
239 "Y"
240 ASTO Y
241 X=Y?
242 XEQ 00
243 XEQ 07
244 END
```

50	

51	
60	
70	
80	
90	
00	

EXHIBIT E

Guide to Film Loading and Downloading (includes the Film Data Sheet).

Film Loading

1. Take camera into the darkroom.

2. Place camera on its back.

3. Unfasten protective cover, as necessary.

4. Unfasten the six latches and remove camera cover.

5. Place empty film core on supply side and turn clockwise one or two turns to free drag brake. Repeat on takeup side, except turn counterclockwise (Figure 1).

6. Remove film from canister. With scissors, cut leading edge and curl edge of film.

7. Install film on supply side (Figure 1).

8. Lift lever lock on metering roller knob to allow metering roller to turn free of the drive mechanism.

9. Position film flat against curved light shield and up against strip as shown in figure, and feed leading edge of film between pressure roller and metering roller (Figure 2).

   Note: Metering roller knob cannot be turned clockwise. Once film has passed between pressure and metering rollers, it cannot be retrieved.

10. Turn metering roller knob enough to grab leading edge of film.

11. Check that film is up against strip. Apply light pressure on film along curved shield and continue turning metering roller knob. Ensure film enters film path straight.

    Note: Check that film does not exit between metering roller and light baffle.

12. Continue turning metering roller knob until film advances between pressure roller and metering roller and exits out between idler roller and film chute. If film does not exit after four or five turns of the metering roller knob, stop and check for film jam.

13. Thread film around takeup spool. Use small piece of tape to secure film to spool.

14. Turn metering knob to take up film slack.

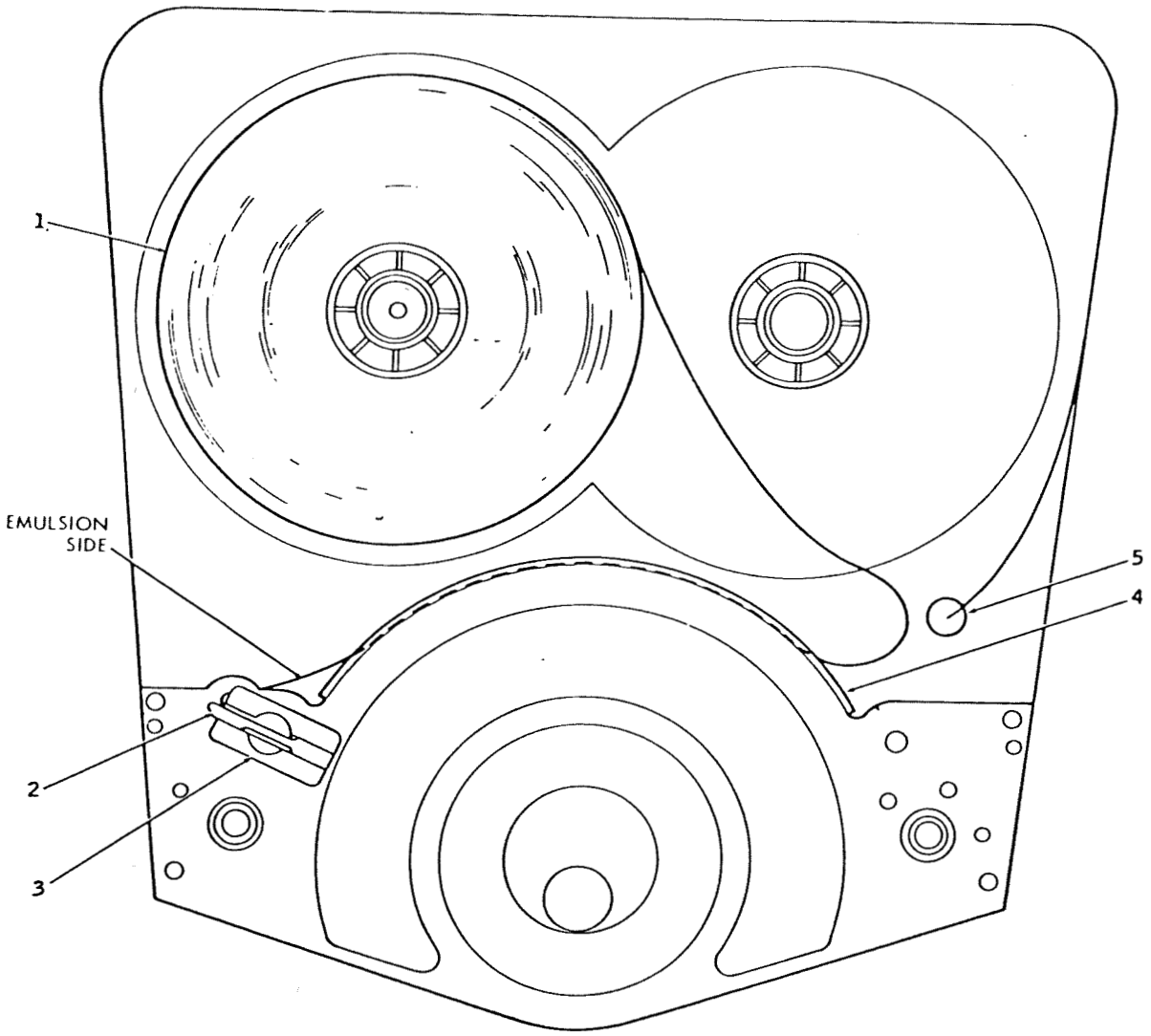
15. Engage metering roller lever lock by flipping lever to locking mode and turning supply spool counterclockwise until lever falls into locking slot.

16. Reinstall front camera cover. Make sure cover is properly seated. Secure the six latches.

Film Downloading

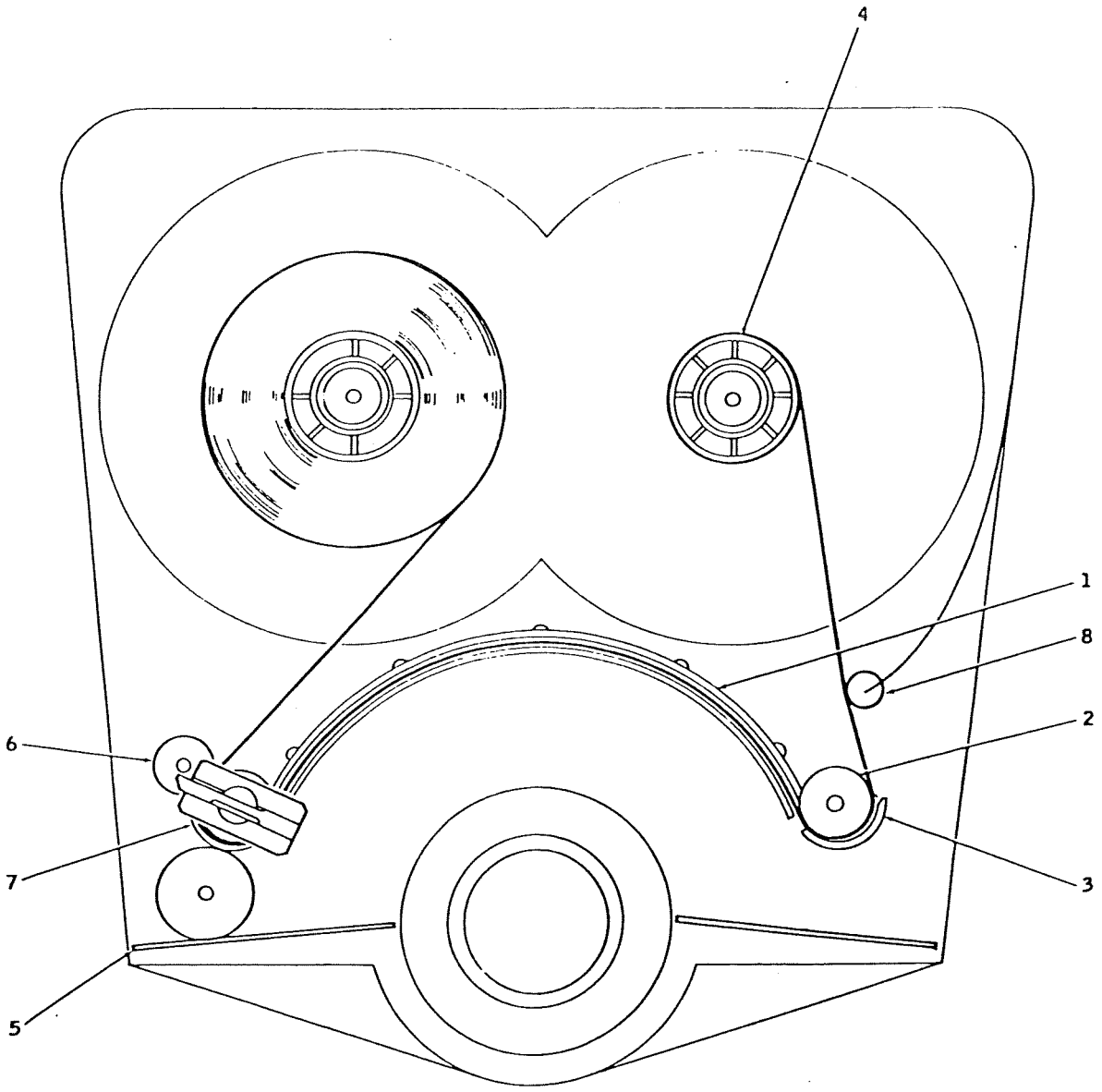
1. Take camera into darkroom.
2. Disengage the six latches for cover.
3. Remove cover.
4. Remove film and store in light-proof container.
5. Reinstall cover.

Note: Exposed portions of film can be removed by providing power to camera and adding five extra frames (leader) to exposed portion of film (takeup roll). Cut film near takeup spool. Remove exposed film. Position new takup spool. Secure film to spool.



1. SPOOL, FILM
2. LEVER LOCK
3. KNOB
4. STRIP
5. ROLLER, ACCUMULATOR

FIGURE 1



1. STRIP
2. ROLLER, IDLER
3. CHUTE
4. CORE, TAKEUP
5. BAFFLE
6. ROLLER, PRESSURE
7. ROLLER, METERING
8. ROLLER, ACCUMULATOR

FIGURE 2

FILM DATA SHEET

1) FILM TYPE: 2448 - 2443 - 2405 - 2402 - 2412 - OTHER _____

2) APPROXIMATE FOOTAGE _____ DATE FLOWN _____

3) KNOWN DAMAGE TO FILM _____

_____

_____

4) NAME, SHIPPING ADDRESS AND PHONE NUMBER _____

_____

_____

FILM DATA SHEET

1) FILM TYPE: 2448 - 2443 - 2405 - 2402 - 2412 - OTHER _____

2) APPROXIMATE FOOTAGE _____ DATE FLOWN _____

3) KNOWN DAMAGE TO FILM _____

_____

_____

4) NAME, SHIPPING ADDRESS AND PHONE NUMBER _____

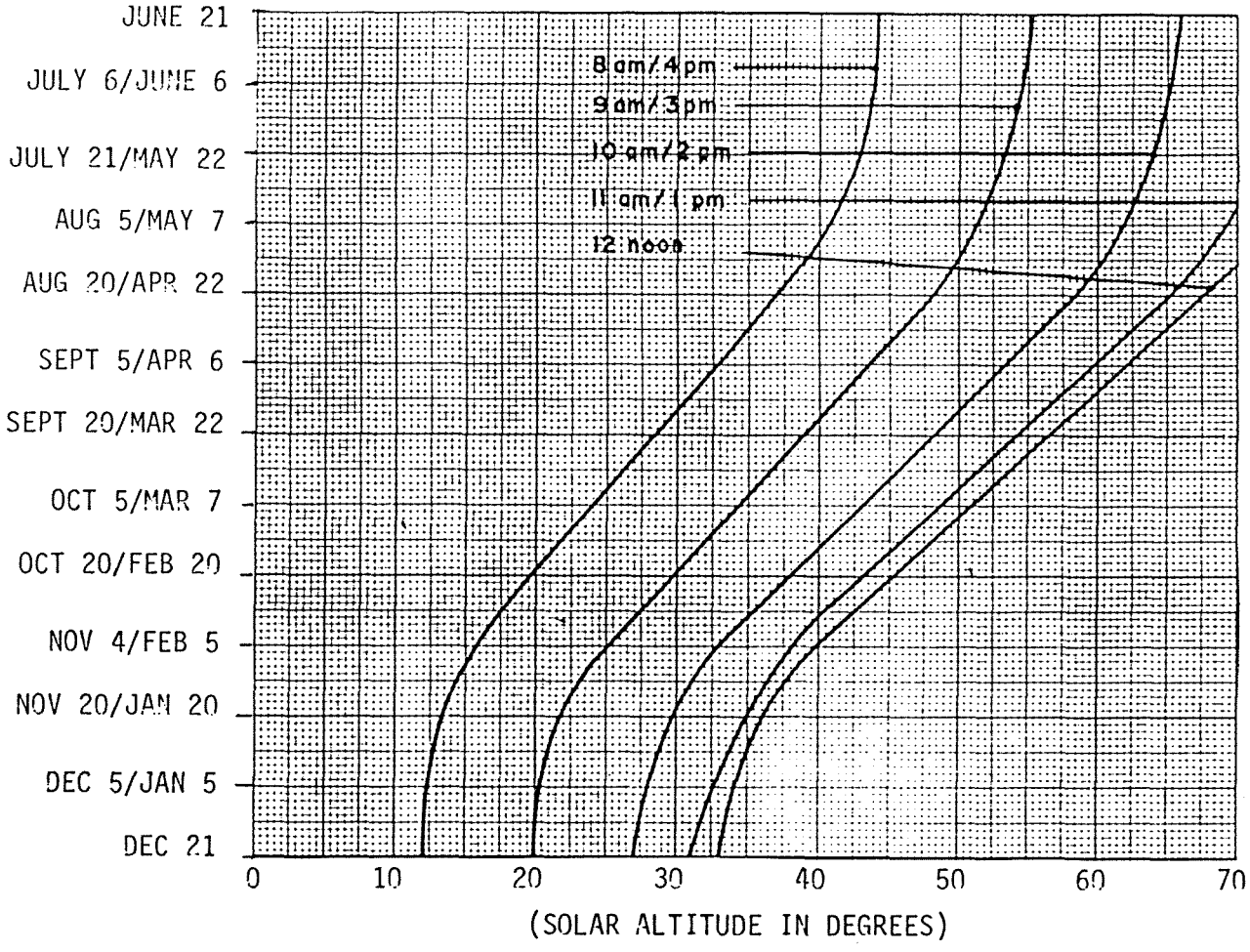
_____

_____

EXHIBIT F

Enviropod Aerial Film Exposure Charts (derived from field data obtained by CRSC).

LATITUDE 30°

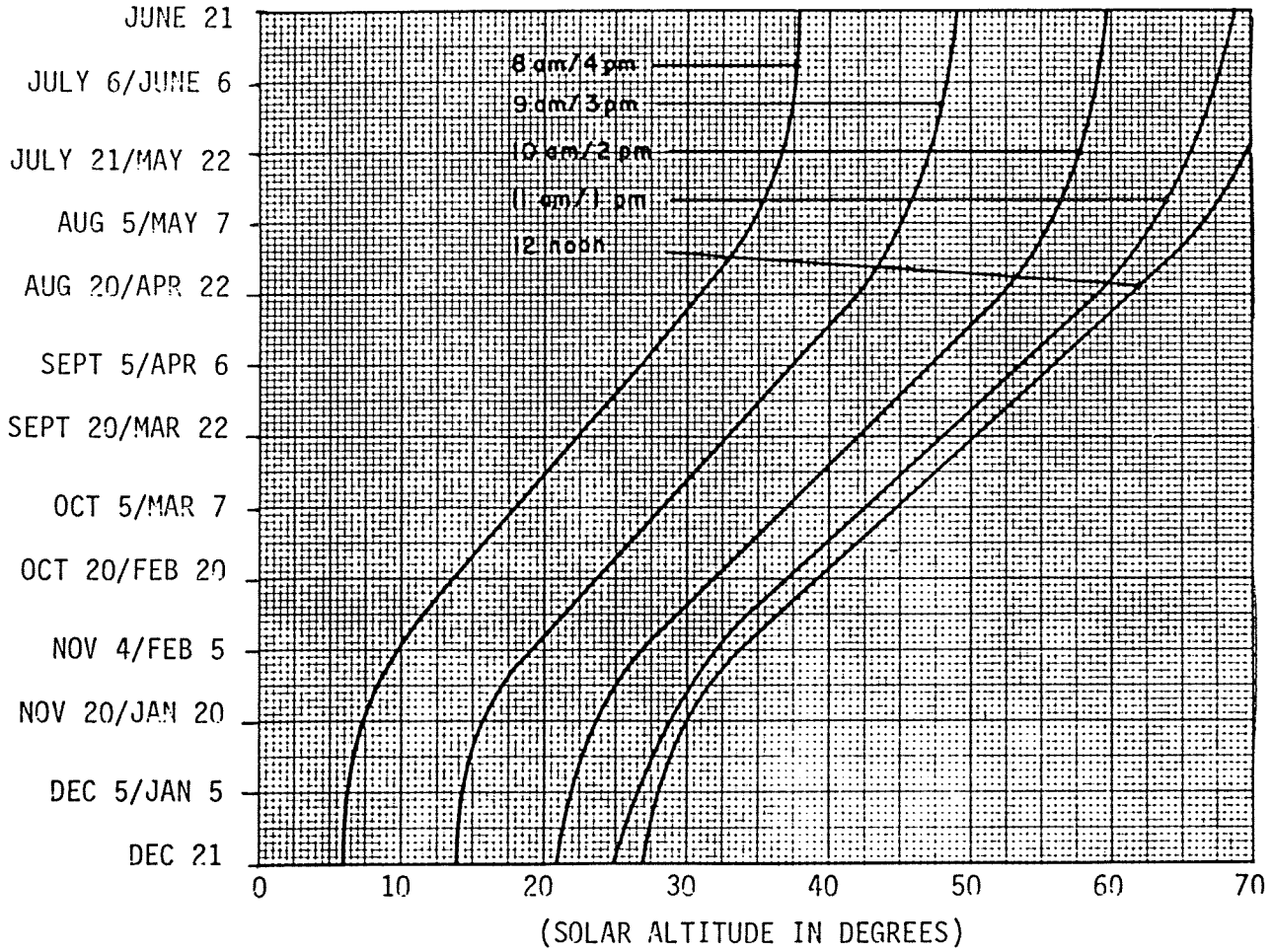


Natural Color and Color Infrared Film
(f-stop at "AGL")

Solar Altitude	10,000' AGL	5,000' AGL	2,000' AGL
7	2.5	2.0	-
10	3.1	2.5	2.0
15	3.8	3.1	2.5
20	4.7	3.8	3.1
30	5.6	4.7	3.8
40	6.4	5.6	4.7
50	7.2	6.4	5.6
60	8.0	7.2	6.4
70	9.2	8.0	7.2

NOTE: Solar altitude is derived from the graph corresponding to time of year and time of day. The f-stop is then selected from the accompanying table according to solar altitude, AGL, and type of film.

LATITUDE 40°

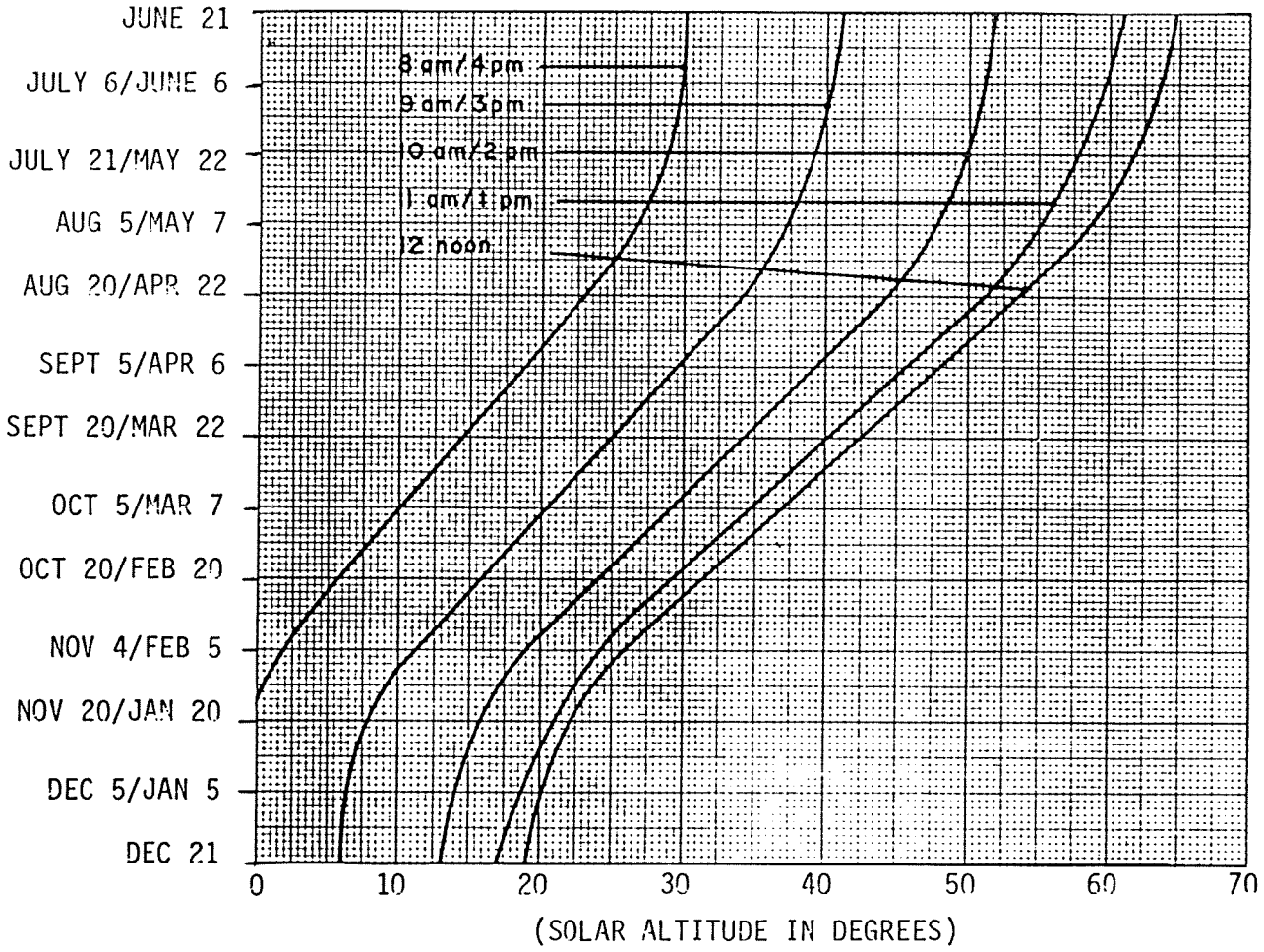


Natural Color and Color Infrared Film
(f-stop at "AGL")

Solar Altitude	10,000' AGL	5,000' AGL	2,000' AGL
7	2.5	2.0	-
10	3.1	2.5	2.0
15	3.8	3.1	2.5
20	4.7	3.8	3.1
30	5.6	4.7	3.8
40	6.4	5.6	4.7
50	7.2	6.4	5.6
60	8.0	7.2	6.4
70	9.2	8.0	7.2

NOTE: Solar altitude is derived from the graph corresponding to time of year and time of day. The f-stop is then selected from the accompanying table according to solar altitude, and AGL.

LATITUDE 50°



Natural Color and Color Infrared Film
(f-stop at "AGL")

Solar Altitude	10,000' AGL	5,000' AGL	2,000' AGL
7	2.5	2.0	-
10	3.1	2.5	2.0
15	3.8	3.1	2.5
20	4.7	3.8	3.1
30	5.6	4.7	3.8
40	6.4	5.6	4.7
50	7.2	6.4	5.6
60	8.0	7.2	6.4
70	9.2	8.0	7.2

NOTE: Solar altitude is derived from the graph corresponding to time of year and time of day. The f-stop is then selected from the accompanying table according to solar altitude, and AGL.

EXHIBIT G

Checklist for the Installation and Removal of the Enviropod Aerial Photographic System.

CHECKLIST FOR THE INSTALLATION AND REMOVAL
OF THE ENVIROPOD AERIAL PHOTOGRAPHIC SYSTEM

A. GENERAL.

1. _____ no smoking will be permitted during any of the activities outlined in the checklist.

2. _____ a minimum of two persons will be required for participation in the activities outlined in the checklist.

3. _____ a mechanic's creeper is required for all activities outlined in the checklist as these are related to the actual installation and removal of the Enviropod Aerial Photographic System. The creeper will have a foam rubber padding to elevate the system to the fuselage of the aircraft and to protect the system during its lowering from the fuselage of the aircraft.

B. TOOL KIT.

1. _____ a compartmented and appropriately labelled tool kit is required for all activities listed in the checklist, said tool kit to include, at a minimum, the following:

- o stop watch to confirm accuracy of intervalometer settings.
- o portable, hand-held, battery-operated vacuum cleaner.
- o flashlight.
- o hand level.
- o optical quality lens cleaning tissues and fluid.
- o angled inspection mirror.
- o cheesecloth wipers.
- o steel tape measure.
- o roll of 2-inch wide duct tape.
- o roll of double-stick scotch tape.
- o small first-aid kit.
- o needlenose pliers with wire cutting element.
- o 7/16th-inch socket wrench.
- o 3/8th-inch socket wrench.

- o 1/8th-inch combination wrench.
- o 10-inch common screwdriver.
- o 6-inch Phillips screwdriver.
- o 1/4-inch ratchet with 6-inch extension.
- o 3/32nd-inch pin to turn turnbuckles.

C. BATTERY CHARGER UTILIZATION.

1. _____ connect battery charger plugs and leads as required, red-to-red (positive) and black-to-black (negative).
2. _____ engage jumper wires.
3. _____ plug charger into 100-volt outlet.
4. _____ turn toggle switch "on".
5. _____ check security of leads.
6. _____ red light on means charger is "on," flashing green lights mean charger is "charging," and when both green lights are on, but not flashing, the "charge is complete."
7. _____ after full charge, pull circuit breakers.

D. AIRCRAFT PREPARATION.

1. _____ check the seat back retainer screws, if these are located on the outside seat rails, move them to the inside seat rails.
2. _____ push the seats to the rearward position; install the forward straps on the seat rails so that the leading edge of each forward strap is midway between the curve of the door sill and the first rivet; tighten the strap bolts and plates to approximately 40-inch/pounds.
3. _____ push the seats to the forward position; install the rear straps on the seat rails so that the trailing edge of each strap is positioned directly over the front edge of the last seat rail retainer screw hole. Unlike the forward straps, leave the rear straps loose to facilitate final adjustment and spacing for the pod attachment.

E. ENVIROPOD PREPARATION.

1. _____ remove the Enviropod and all related equipment from the transport vehicle and place them on the ground near the creeper and on the pilot's side of the aircraft.

2. _____ remove the four "T-lock" toggles from the tool kit and join the "A" and "B" pod sections.

3. _____ place the now joined sections on the creeper and in normal position.

4. _____ bolt the four turnbuckle hinge assemblies to the hinge mounts on the sides of the sections, ensuring that all nuts are aft; tighten snugly but do not force these.

5. _____ remove the pod section covers by removing the four screws from each section, these are spring tension screws and are to be snapped then turned; store these screws and washers in the tool kit.

6. _____ remove all loose equipment from the pod sections and place nearby on the ground.

7. _____ turn the pod on its side and remove the camera window cover plates; inspect the windows and, if required, clean inside and out using lens tissues and fluid, return to normal position on pod.

8. _____ remove the battery jumper wires from the front camera section and run these to the terminals, being certain to attach black-to-black and red-to-red.

9. _____ remove the oblique and vertical cameras from their respective cases, place the cameras on top of the case, not on the ground; note that the mounting brackets for the vertical camera are in place while those for the oblique camera are stored in the tool kit and must be attached.

10. _____ with the .25-inch No. 28 bolts provided, attach the oblique mounts to the oblique camera always observing the line-of-flight directional arrow on the camera.

11. _____ connect the vertical and oblique camera control cables.

12. _____ connect the intervalometer ribbon line from the pod to the intervalometer.

13. _____ activate the electrical system by engaging the circuit breakers.

14. _____ adjust, on both cameras, the f/stops as required and set the intervalometer mode switches to "autocycle" disregarding the cycle rate switch; install selected filter for camera with IR film, if any.

15. _____ turn the intervalometer to "on", check the cycling time with the stopwatch, set with dial and lock; cycle two test frames on each camera and then reset frame counter to zero; adjust if required and then check the "extra" picture switch (red button on intervalometer); If the intervalometer cycle or the "extra" picture switch do not function properly, check all lines to the power source.

16. _____ if all systems check out, install the cameras in their respective pods, being certain that they are mounted correctly in relation to the line-of-flight directional arrows; set the retaining screws to secure the cameras.

17. _____ disconnect the intervalometer and place it on the right front seat of the aircraft; at this time be certain that the ribbon line remains outside of the pod section.

F. ENVIROPOD ATTACHMENT.

1. _____ roll the creeper, with completed pod system mounted on it, to a position under the aircraft fuselage; align the pod so that the forward lip is approximately 7-inches forward of the fuselage skin line at the wing strut; align the pod along the center line of the aircraft using the nose wheel strut as a reference.

2. _____ install the front-left and front-right turnbuckles; completely remove the bolt barrel by aligning it with the strap bolt and then turn the barrels until several threads are exposed at the top; if required use the 3/32-inch pin to turn the turnbuckles but always fully insert the pin to prevent its bending or shearing; the annular groove of the turnbuckle should be at the bottom.

3. _____ install the rear-left and rear-right turnbuckles using the same procedure outlined above; alternately tighten all four turnbuckles in order to secure the pod to the fuselage with minimum differential stress.

4. _____ align the turnbuckles so that the grooves in the threads are in line with the barrels in order to admit the wire safety clips.

5. _____ install the safety clips in the strapward end of each turnbuckle barrel and snap these into the hole in the center of each barrel; do not force the clips into place.

6. _____ with the pod secured and aligned, tighten the rearward straps and plates which were earlier left loose (see D. 3., above).

7. _____ tape the door sill with five pieces of duct tape at the aft position of the front strap (cushioning tape); then tape the ribbon line of the intervalometer to the fuselage and over the cushioning tape on the door sill; add three pieces of tape to the ribbon line (chafing prevention tape).

8. _____ repeat the camera operating test from the right front seat of the aircraft (see E. 14-16., above).

9. _____ stow all loose equipment as appropriate in the tool kit or transport vehicle and remove the creeper.

G. PREFLIGHT CHECKS.

1. _____ check to confirm correct positioning, alignment and clearance of the Enviropod, the latter not to be less than 4 inches from the ground.

2. _____ check to confirm the positioning and security of straps, turnbuckles and safety clips.

3. _____ confirm that the pilot has the Supplemental Type Certificate (STC) on board; using double-stick tape, attach placards a and b (See Exhibit A.) to the aircraft instrument panel adjacent to the airspeed indicator.

4. _____ confirm that preflight maintenance records in general and engine hour operation count specifically, have been made; make preflight entries in both the flight log and the photo log.

5. _____ before departure, press the "extra" picture switch (red button) for each camera/intervalometer to ensure that the power source, all lines, and the camera/s are functioning properly, it may be desirable to engage the intervalometer for one or two frames as a final check on each camera; reset counter to zero.

H. ENVIROPOD REMOVAL.

1. _____ after the aircraft has come to a full stop and the engine is shut down, initiate removal of the Enviropod.

2. _____ cycle the cameras through three exposures in order to provide a film trailer and to facilitate film handling with minimum risk of exposure.

3. _____ place the tool kit and creeper under the pod.

4. _____ remove tape attaching the intervalometer ribbon line control cable to the fuselage and remove all duct tape padding and cushioning.

5. _____ disconnect and remove the intervalometer from the right-front seat and place it in its storage case with the battery charger.

6. _____ remove safety clips from turnbuckle and place these in the tool kit.

7. _____ back all turnbuckles off one half length.

8. _____ completely disengage the turnbuckles, first the two on the left side of the pod, then the two on the right side of the pod; this sequence will minimize stress on the straps.

9. _____ lower pod to the creeper, roll the creeper away from the aircraft; disconnect the battery jumper wires and deactivate the system by pulling the circuit breakers.

10. _____ remove the cameras from the pod sections, remove oblique mount brackets and store these in the tool kit; place each camera in its respective case.

11. _____ place all loose equipment in the forward pod section, or as appropriate to size in the tool kit.

12. _____ turn the pod on its side on the creeper and inspect the camera windows and, if required, clean them; replace window cover plates.

13. _____ turn pod upright, replace protective pads; disengage the four T-bolts and place these in the tool kit.

14. _____ replace pod covers on their respective sections.

I. POSTFLIGHT CHECKS.

1. _____ ensure that the pilot has removed the two placards from the instrument panel and has the STC in his possession.

2. _____ confirm the photo and flight log entries with the pilot; confrom that the appropriate maintenance record entries have been made.