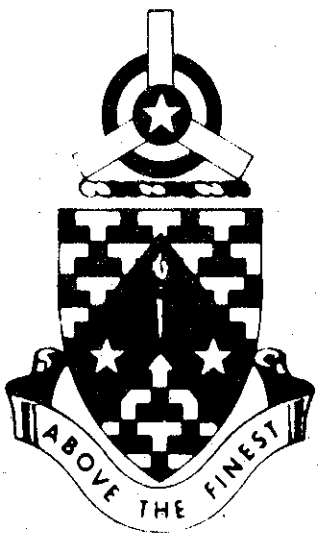
PROGRAMED TEXT

MAP READING
Part VII
AERIAL PHOTOGRAPHY

WD-42



AUGUST 1968

UNITED STATES ARMY
PRIMARY HELICOPTER SCHOOL
FORT WOLTERS, TEXAS

PROGRAMED TEXT

PROGRAM TEXT

FILE NO: WD-42

PROGRAM TITLE
Map Reading
Part VII
Aerial Photography

POI SCOPE: Determining the scale (RF) of aerial photographs, orientation of photos using sun-time-shadow method, construction of point designation grid.

INSTRUCTOR REFERENCES:

FM 21-26

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August 1968

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Map Reading - Part VII

PREFACE

Part VII covers two (2) methods used to identify terrain features on aerial photographs. To use an aerial photograph as a map substitute or a map supplement, you must be able to identify the features appearing on it.

In identifying features on an aerial photograph, a point designation grid must be constructed so that the same point can be found by anyone referring to the photograph. Photo scales are constructed to help an aviator correlate the ground with the photograph. In using an aerial photograph, keep in mind the following basic facts:

1. Unfamiliar View. An aerial photograph presents a view from above and as a result, objects appear to be different.

2. Reduction in Size. Objects being greatly reduced in size causes them to appear differently.

3. Lack of Color. Most aerial photographs are in black and white and all colors appear on them as shades of gray.

4. Lack of Legend. Aerial photographs do not normally have a legend or symbols to identify the features appearing on them.

NOTES:

The following materials are essential in answering the frames in this text:

Map of MINERAL WELLS, TEXAS, 1:50,000

Aerial Photograph

Coordinate Scale

PERFORMANCE OBJECTIVES

Upon completion of Part VII you will be able to:

A. Identify an Aerial Photograph as one of three types.

B. Orient a photo for study.

C. Determine north on a photo by two methods: Map Orientation and Shadow Orientation.

D. Compute the RF factor of a photo when given Photo and Ground Distance or Focal Length and Altitude.

E. Construct point designation grid lines on a photo.

F. Recognize features on a photo using the SSSTR recognition factors.

PART VII

AERIAL PHOTOGRAPHY

Set 1. TYPES OF AERIAL PHOTOGRAPHS

FRAME 1

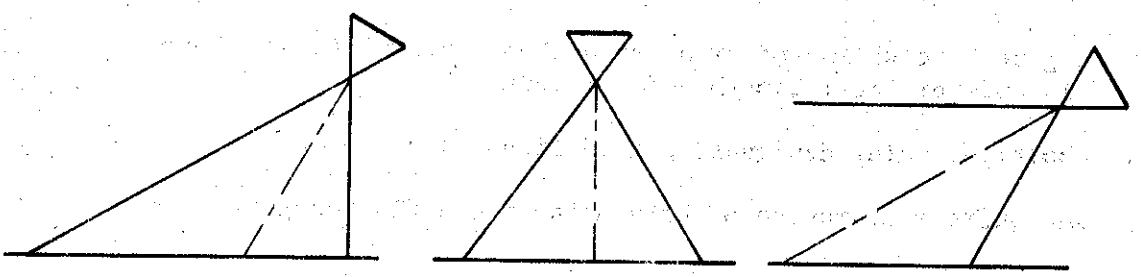
There are three types of aerial photographs.

a. The vertical photo is taken with the camera pointing straight down.

b. The low oblique photo is taken with the camera pointing at an angle, but not enough to show the horizon.

c. The high oblique photo is taken with the camera tilting enough to show the earth's horizon.

Assuming the dotted line to be the lens angle of the camera, match the following with the type of photo each will produce.



1. b 2. a 3. c

(Flight Altitude - a. 2500 feet; Focal Length - b. 5 inches) (10)

Set 4. SCALE OF PHOTOGRAPHS (MEASURING GROUND DISTANCE)

FRAME 11

Scale measurement on a vertical aerial photograph depends on the ground area covered by the photograph. The scale (RF) of the photo is similar to the map (RF).

$$\text{RF (photo)} = \frac{\text{distance on the photo}}{\text{ground distance}} = \frac{PD}{GD}$$

The photograph's RF is the ratio or fraction of photo distance to ground distance.

($\frac{1}{30,100}$ or $\frac{1}{30,000}$) ($\frac{12"}{31,000 - 900} = \frac{1}{30,100}$ or 1:30,000) (19)

FRAME 20

To compute ground distance using the formula GD = PD X D (D is the denominator of the RF), you must know the RF of the photo and you must measure the distance on the photo. If you measure 1 inch on the photo and the scale of the photo is 1:59,000, you get ground distance (GD) = PD (1") X D (59,000) = 59,000".

(495495) (29)

FRAME 30

Refer to the aerial photograph supplied with this text.

Number the grid lines using the system explained in the previous frames.

Check your numbering with step 4 in Frames 27 and 28. Read the photo and find the grid square in which the fork in the highway appears.

a. 4850
b. 4950
c. 5051

(1.- b; 2.- a; 3.- c) (1)

FRAME 2

The low oblique photo will give you a more familiar view of the objects on the ground. Label the photos on the following page by type.

1. Vertical straight down
2. Low Oblique small ∠
3. High Oblique large ∠

(photo) (11)

FRAME 12

In computing photo RF, both ground distance and photo distance must be the same unit of measurement. If inches are used in the numerator (photo distance) (upper part of fraction), inches must also be used in the denominator (ground distance) (lower part of fraction). The distance between two points on the photograph is 1 inch. On the ground the distance measures 1 mile (5,280 feet or 63,360 inches).

What is the photo's RF?

a. $\frac{1}{1}$

b. $\frac{1}{5,280}$

(c.) $\frac{1}{63,360}$

(distance; 59,000") (20)

FRAME 21 REVIEW FRAME

There are three methods of measuring scale and distance on photographs:

(1) Measurement on ground and photo.

$$RF\ (photo) = \frac{\text{distance on the photo}}{\text{ground distance}}$$

(2) Comparison with map.

To get RF (photo) by comparison with map of the same area,

$$\text{Photo RF} = \frac{\text{photo distance}}{\text{map distance}} \times \text{map RF}$$

(3) Marginal data and average ground elevation (map or local data).

$$RF\ (photo) = \frac{fl}{H-h}$$ (Using marginal data plus average ground elevation [h].)

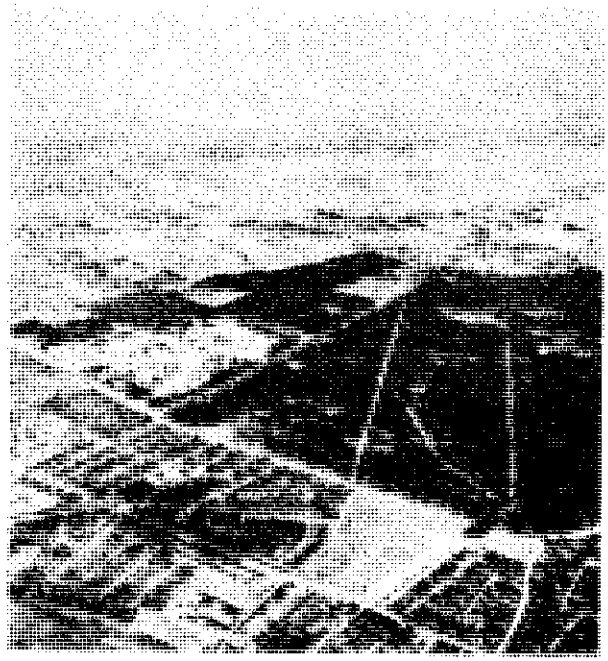
(a. 4850) (30)

FRAME 31

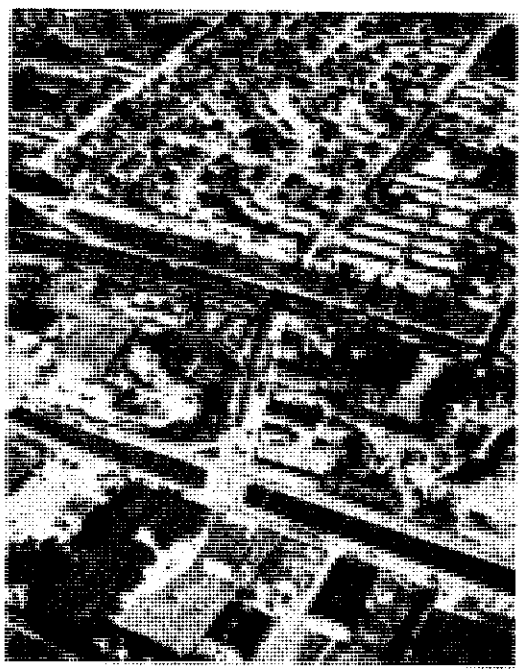
The 4-cm grid squares on the photo are the same size as the RF 1:25,000 meter scale on the coordinate scale furnished with this text. Using the 1:25,000 meter scale, which of the following locates a road junction in grid square 5150?

a. 500490
b. 502492
c. 516501

A



B



C

FRAME 3

A. vertical

B. high oblique

C. low oblique

Which type of photo is the one supplied with your text? vertical

GO TO PAGE 8 FOR FRAME 13

Set 5. LOCATING POINTS BY POINT DESIGNATION GRID

FRAME 22 INFORMATION FRAME

To locate points on an aerial photograph a point designation grid is used. On a map the distance between grid lines represents (indicates) a certain distance on the ground. On the aerial photograph the point designation grid cannot represent ground distance because the scale of the photo varies with the height at which the aircraft was flying. The point designation grid is used solely for locating points on a photograph.

(c. 516501) (31)

FRAME 32

To review, the lines on a point designation grid cannot be used to find either distance or direction on the ground. They can be used only for which of the following?

a. Determining direction
b. Locating points
c. Measuring distances

(A. Vertical; B. High Oblique; C. Low Oblique; Your photo is a vertical photo.) (3)

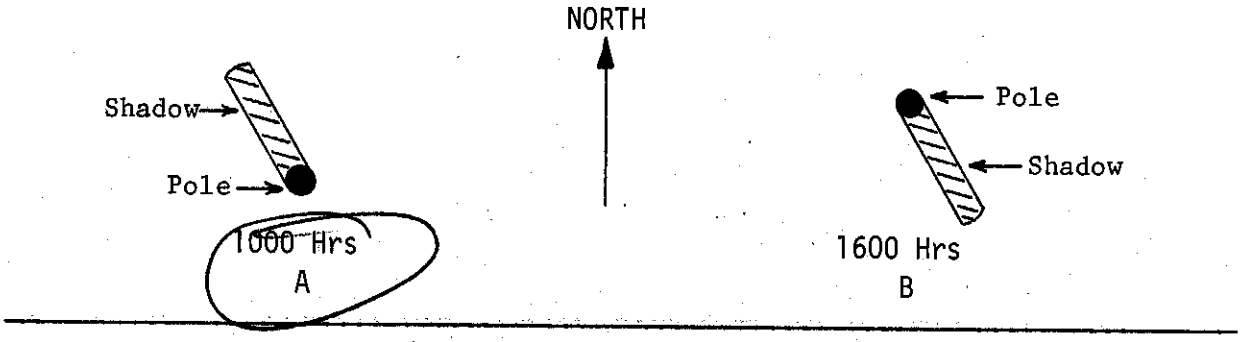
Set 2. FINDING DIRECTION ON A PHOTO

FRAME 4

Directions on an aerial photograph are not shown as on a map, therefore shadows may be used to find north.

In the north temperate zone, shadows will fall in a northerly direction since the sun's vertical position is always within 23 1/2° north and 23 1/2° south of the equator.

Circle the letter of the following illustration that is correct.



(c. $\frac{1}{63,360}$) (12)

FRAME 13

Photo RF can also be computed by comparison with a map of the same area using the formula:

$$\text{Photo RF} = \frac{\text{photo distance}}{\text{map distance}} \times \text{map RF}$$

Example: Photo distance between two points is 10 centimeters. On a 1:50,000 scale map, the map distance between the same two points is 5 centimeters. Substituting in the formula:

$$\text{Photo RF} = \frac{10}{5} \times \frac{1}{50,000}$$

What is the photo RF?

a. $\frac{1}{25,000}$ b. $\frac{1}{50,000}$ c. $\frac{1}{100,000}$

FRAME 23

The point designation grid is added by the user to each photograph. Copies of the same photograph may be used by many different people. Therefore, each user must draw the point designation grid exactly the same way. Otherwise, the point location on one copy will not agree with the pt. location on the copies.

(b. locating points) (32)

FRAME 33 INFORMATION FRAME

The identification of features on an aerial photo depends upon a careful application of five (5) factors of recognition.

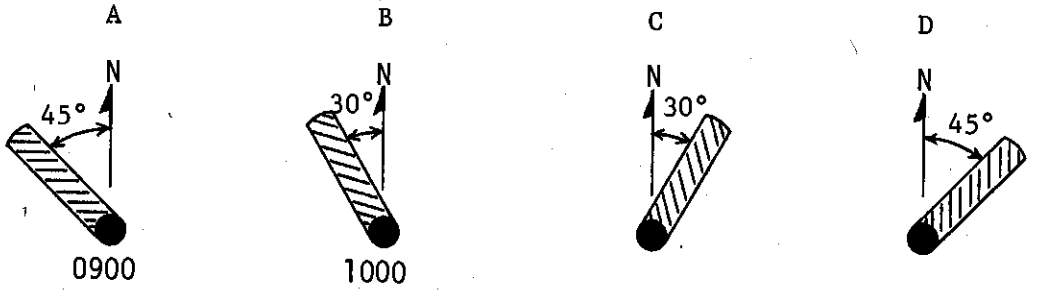
a. Size	- Comparison with known objects of known size gives a clue to the identity of unknown objects.
b. Shape	- Man-made features have regular shapes, straight lines and smooth curves; while natural features have irregular shapes.
c. Shadows	- Are helpful since they show the familiar side view of the object. e.g., water tower.
d. Tone	- A smooth texture, e.g., paved highway, produces an even tone, while a rough or choppy texture, e.g., plowed field, results in a rough or grainy tone.
e. Relation to other objects	- An object not easily recognized by itself may be identified by surrounding objects.

You may find these easier to remember if you refer to them as the SSSTR recognition factors.

(A) (4)

FRAME 5

In the morning, shadows will fall to the northwest and will move east at the rate of 15° per hour. At noon, they will point due north. In the afternoon, the shadows will continue east at the rate of 15° per hour.



Check the times that C and D depict.

1. 1400
2. 1300
3. 1600
4. 1500

(a. $\frac{1}{25,000}$) (Photo RF = $\frac{\text{photo distance}}{\text{map distance}}$ X map RF = $\frac{10}{5}$ X $\frac{1}{50,000}$ = $\frac{1}{25,000}$)
(13)

FRAME 14

The photo RF ratio, $\frac{\text{photo distance}}{\text{ground distance}}$, is the same proportion as $\frac{\text{focal length of lens}}{\text{height of camera}}$. That is, $\frac{\text{photo distance}}{\text{ground distance}} = \frac{\text{focal length of lens}}{\text{height of camera}}$.

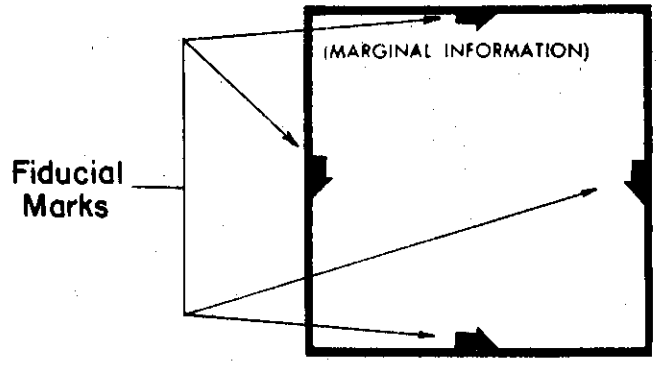
What is the lens' focal length given on the photo furnished with the course?

a. 37
b. 6 inches
c. 30,000 feet

(point location) (23)

FRAME 24

Step 1. Orient the photo with the marginal information in the normal reading position. Step 2. Locate the center of the four edges of the photograph. Some photographs have reference marks, called "fiducial marks," which mark the center of each edge.



FRAME 34

Refer to your aerial photograph. The SSSTR factors will be used to identify the warehouses at Fort Wolters (4950).

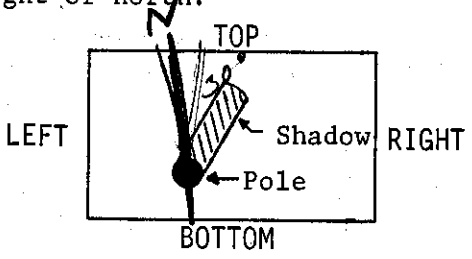
1. The "objects" are much larger than a house when compared with the SIZE of houses on post.
2. The rectangular appearance or SHAPE identifies these as man-made structures.
3. The SHADOWS cast by both structures indicates that they are taller than houses.
4. The TONE of the roofs is slightly different from the surroundings.
5. The RELATION to other warehouses and storage yards with a railroad running through it makes an almost positive identification as a warehouse.

(C - 1400; D - 1500) (5)

FRAME 6

To find north on a photo, first determine when the photo was taken. Next, decide in what direction the shadows are pointing. You can then find north by constructing a north-south line from the shadow.

Example: If the photo was taken at 1400, then the shadow direction should be 30° to the right of north.



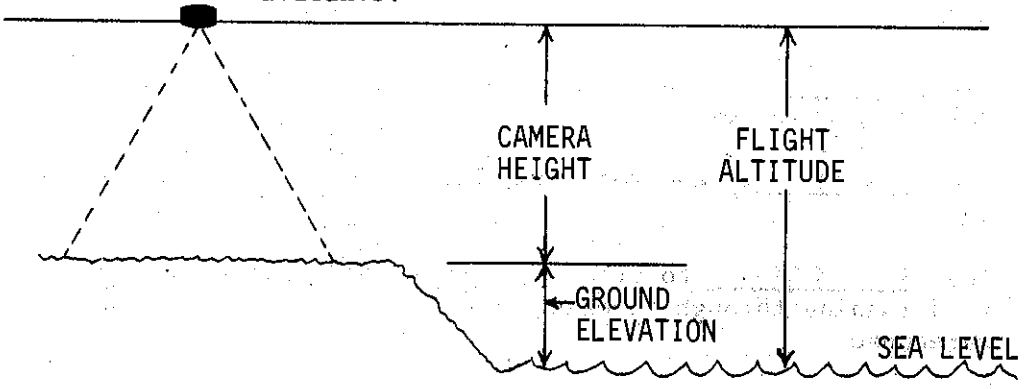
North then could be found by constructing a line 30° West of the shadow (1400 - 1200 = 2 hrs X 15° per hr = 30°). North in this case would be:

a. Top
b. Bottom
c. Left
d. Right

(b. 5 inches) (The focal length of the lens is given as 5 inches.) (14)

FRAME 15

The flight altitude, given on the photograph, is measured from mean sea level (average sea level) and so is the ground elevation. To obtain average ground elevation, you can either use a topographic map of the same area as YOUR photo or if the map is not available, obtain the average ground elevation from the local inhabitants.

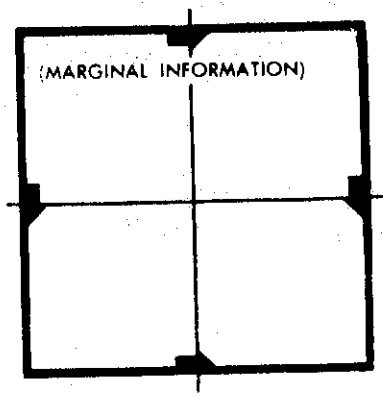


What is the height of the camera if the flight altitude (obtained from marginal information) is 3000 ft. and the ground elevation (obtained from topographical map) is 1000 ft.? 2000 ft

(center) (24)

FRAME 25

Step 3. Connect opposite fiducial marks with straight lines. The horizontal and vertical lines will cross at the center of the photograph.



(size, shape, shadow, tone, relation) (34)

FRAME 35

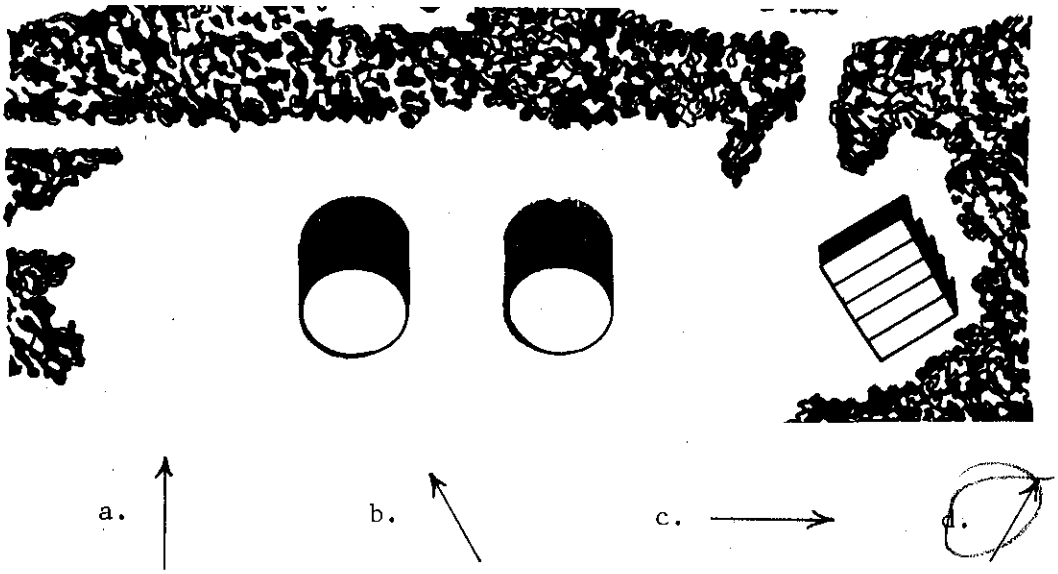
Match each of the following features with the recognition factor that will best enable you to recognize the feature.

a.	Size	c	1. Oil derrick
b.	Shape	d	2. Plowed field
c.	Shadow	e	3. Ship yard
d.	Tone and texture	b	4. Football field
e.	Relation to other objects	a	5. Warehouse

(a. Top) (6)

FRAME 7

Look at the following photograph and determine north on the photograph if it was taken at 1000. Circle the correct answer.



(2,000) (15)

FRAME 16

The RF ratio can now be expressed as:

$$\text{Photo RF} = \frac{fl}{H-h} \text{ where:}$$

fl = focal length
H = flight altitude
h = ground elevation

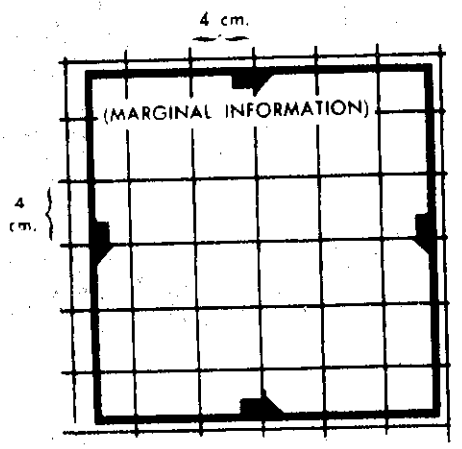
Which of these values is not given in the marginal information?

a. fl
b. H
c. h

(center) (25)

FRAME 26

Step 4. The rest of the grid lines are spaced exactly 4 centimeters (1.575 inches) apart, starting from the center lines in each direction. Each square in all point designation grids measures 4 cm on each side.



(1. c; 2. d; 3. e; 4. b; 5. a) (35)

END OF PART VII

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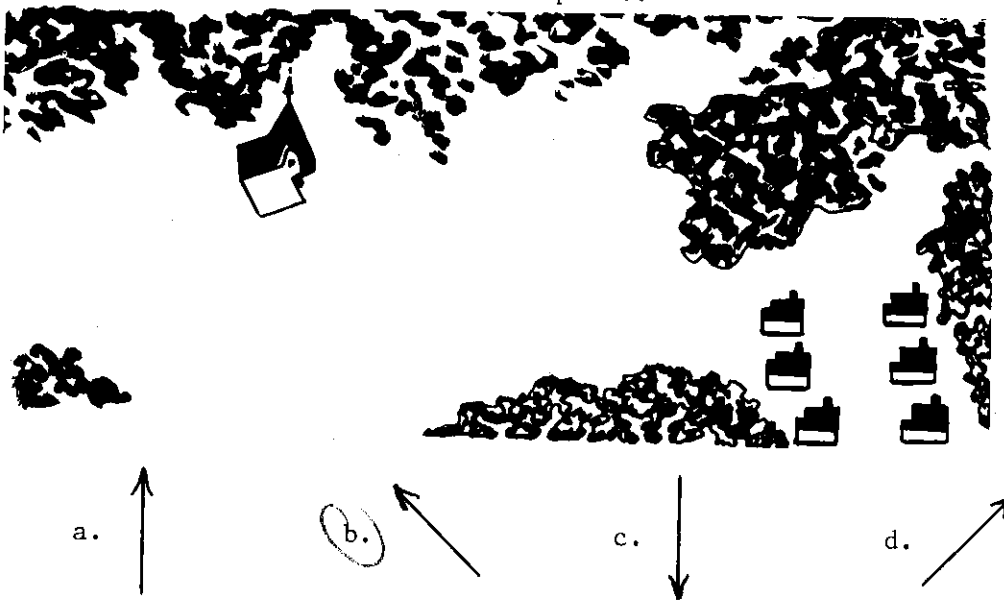
(d) (7)

FRAME 8

Look at the following photograph and determine north if the photograph was taken at 1500. Circle the correct response.



(c. h) (The ground elevation is not given on the photo; the other two, H = altitude, and fl = focal length of camera are given.) (16)

FRAME 17

To determine the average terrain elevation of your photo refer to your Mineral Wells map. The intermittent streams in the photo are approximately 810 feet above sea level. The highest elevation, in the Camp Dallas area, is about 890 feet. The average terrain elevation (h) is:

$\frac{810 + 890}{2}$ or 850'.

(4 cm) (26)

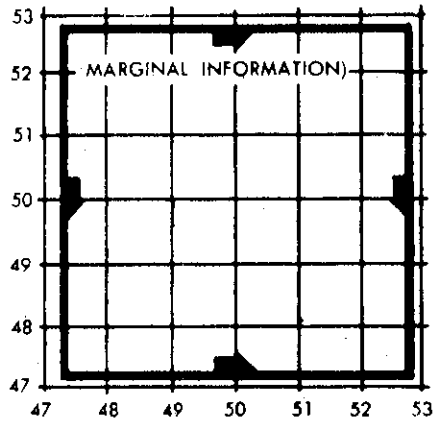
FRAME 27

Step 5. To number the grid lines, remember to have the photo oriented with the marginal information in the normal reading position. The center lines, both vertical and horizontal, are numbered 50. The numbers will increase right on the vertical lines and up on the horizontal lines.

Find grid square 4850 reading right and up.
Will this square always be in the same relative position on any photograph?

a. Yes

b. No



(b) (8)

FRAME 9

To orient a photo for study, first turn to face a source of light such as a window or a lamp. Next, turn the photo until the shadows of the objects in the photo point toward you. With the photo oriented this way, an illusion of relief is created. The shapes are apparent although their size is not measurable. Refer to your aerial photo. If you look closely at it, you may be able to see that the shadows point toward the left side. To orient this photo for study, you must turn the left side

a. toward you.

b. away from you.

(850 feet) (17)

FRAME 18

To compute the RF, using the formula RF = $\frac{f1}{H-h}$, you transfer the f1 and H values from the marginal information of your aerial photo and use the 850 feet from the map for h.

$$\text{Photo RF} = \frac{f1\ (5")}{H\ (2{,}500\ ft) - h\ (850\ ft)}$$

You must now convert feet to inches as follows:

$$RF = \frac{5"}{1{,}650\ ft \times 12} = \frac{5"}{19{,}800"} = ?$$

What is the RF computed from the marginal information on the photo and the elevation from the map?

a. $\frac{1}{1{,}650}$ b. $\frac{1}{300}$ c. $\frac{1}{3{,}960}$

(a. yes) (27)

FRAME 28

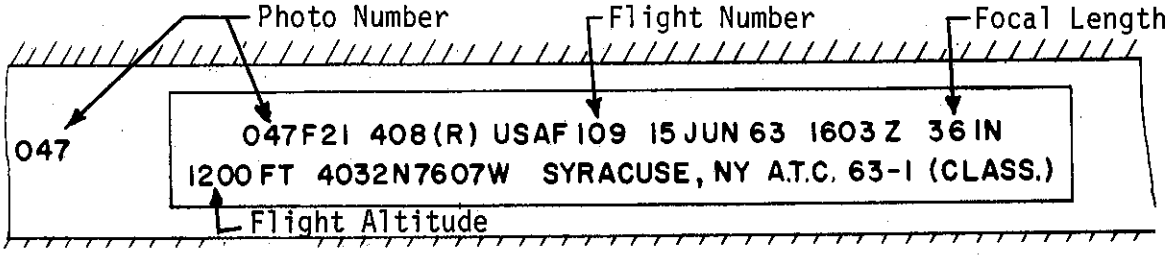
Points are located on the point designation grid using 6-digit coordinates (as on a map). A 3-digit reading to the right is combined with a 3-digit reading up.

(a) (9)

Set 3. USE OF MARGINAL INFORMATION ON PHOTOS

FRAME 10

Information on how, when and where the aerial photo was taken is placed in the margin of the photo. This information enables the user to "read" the photo properly, including the identification of objects on the ground and the determination of ground distance.



Using the information above as reference material, select from the following the flight altitude and focal length of your photo.

(a.) 2500 feet	a. 56 inches
b. 3000 feet	(b.) 5 inches
c. 56,000 feet	c. 7 inches
d. 2035 feet	d. 8 inches

RETURN TO BOTTOM OF PAGE 2 FOR FRAME 11

(c. $\frac{1}{3,960}$) (2,500 - 850 = 1,650; $\frac{5"}{1,650' \times 12} = \frac{5"}{19,800"} = \frac{1}{3,960}$)
(RF = 1:3,960. For most photo distance measurements, the rounded off value, 1:4000, is accurate enough.) (18)

FRAME 19

Given a photograph with a focal length of 12" and an altitude of 31,000', compute the RF if you do not have a topographic map of the area, but are given the average ground elevation of 900 feet by people living in the area.

Using the formula, photo RF = $\frac{fl}{H-h}$ = ?

$\frac{12"}{30,100'} = \frac{1'}{30,100}$

RETURN TO TOP OF PAGE 3 FOR FRAME 20

(3; 3) (28)

FRAME 29

The first 2 digits (both right and up) are the two figures with which the lines are numbered and are the lower left hand corner of the grid square. The third digit (in each instance) is the distance measured within the grid square. Thus, a point located in the exact center of grid square 4949 has a 6-digit coordinate of 495495.

RETURN TO BOTTOM OF PAGE 3 FOR FRAME 30

SELF EVALUATION EXERCISE
PART VII

This exercise will test what you have learned from this programed text. Read each question carefully and select the correct answer.

1. Which type of photo will give you the most familiar view of objects on the ground?

   a. Vertical
   b. Low Oblique
   c. High Oblique
   d. Composite

2. Which type of photo will give you the most unfamiliar view of objects on the ground?

   a. Vertical
   b. Low Oblique
   c. High Oblique
   d. Composite

3. Select the correct distance for grid lines in constructing grids using the point designation grid system.

   a. 4 cm
   b. .5 inches
   c. 50 cm
   d. 4 inches

4. What is the first step in constructing a Point Designation Grid on a photograph?

   a. Place north at the top.
   b. Orient the photo with the shadows toward you.
   c. Place the marginal information in the normal reading position.
   d. Orient the photo with rivers and streams running from top to bottom.

5. Select the number that would show the center of the Photo using the Point Designation Grid System.

   a. 499481
   b. 5050
   c. 5555
   d. 4545

6. Select from the following, three elements that appear in the marginal information on a photo.

a. Focal Length, Altitude, Ground Elevation
b. Scale, Altitude, Photo Number
c. Declination Diagram, Altitude, Date
d. Altitude, Focal Length, Photo Number

7. If a photo was taken at 14,000 feet with a focal length of 12 inches and the terrain elevation of 4,000 feet, what is the scale of the photo?

a. $\frac{1}{10,000}$

b. $\frac{1}{25,000}$

c. $\frac{1}{2,400}$

d. $\frac{1}{83}$

8. If the distance between two points on the photo is 2 cm and the same distance on a map is 4 cm, what is the photo scale if the map scale is 1:50,000?

a. $\frac{1}{25,000}$

b. $\frac{1}{200,000}$

c. $\frac{1}{100,000}$

d. $\frac{1}{250,000}$

9. If the length of the heliport is 100 yards and on the photo it is 1 inch, what is the scale of the photo?

a. $\frac{1}{25,000}$

b. $\frac{1}{100}$

(c) $\frac{1}{3,600}$

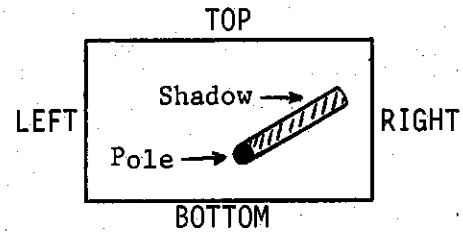
d. $\frac{1}{1,200}$

100 × 36 = 3600

1/3600

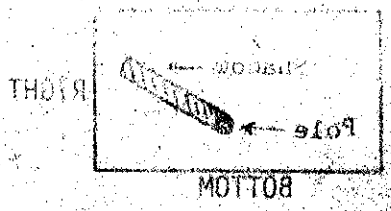
10. This diagram shows a pole with its shadow. The time is 1030 hrs. Which direction is north?

a. Top
b. Bottom
(c) Right
d. Left



ANSWERS TO SELF EVALUATION EXERCISE - PART VII

1. b
2. a
3. a
4. c
5. b
6. d
7. a
8. c
9. c
10. c



L1834-Army-Ft. Sill, Okla.