

Glossary

Notation

a	Distance accuracy denominator
b	Elevation difference accuracy ratio
B	The air distance between consecutive exposure stations; air base between exposures in a strip of photographs
d	Distance between survey points; distance between control points in kilometers measured along the level route; photograph image distance; image displacement; negative format dimension
D	Density; ground dimension of a central panel of a target; horizontal ground distance
$D-min$	Minimum density
$D-max$	Maximum density
E_{lap}	Required photo end lap
f	Camera focal length
g	Gradient
G	Ground coverage of one side of a square format photograph
h	Elevation above datum of the point
h_{ave}	Average ground elevation in a photograph
h_{base}	Elevation at the object base above datum
h_p	Ground elevation of point p
ht	Vertical height of an object
H	The flight height above mean ground height
m_{ij}	Nine direction cosines expressing the angular orientation
N	Geoid separation above an ellipsoid
p	Parallax; photo width
P_a	Parallax of the image point
r	Radial distance from the principal point to the image point

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s	Propagated standard deviation of distance between survey points obtained from a weighted and minimally constrained least squares adjustment
S	Photographic scale at a point
S_{ave}	Average photographic scale
S_{lap}	Required side lap
t	Photo tilt angle
W	The ground distance between adjacent flight lines
y_{\square}	Auxiliary photocoordinate
x, y	Photocoordinates
x_o, y_o	Principal point photocoordinates
x_p, y_p	Photocoordinates of point p
X, Y	Horizontal ground coordinates
X, Y, Z	Ground point coordinates
X_L, Y_L, Z_L	Exposure station coordinates
X_p, Y_p	Ground coordinates of point p
ω, ϕ, κ	System defining angular rotation in a photograph in which ω is a rotation about the x photographic axis, ϕ is about the y-axis, and κ is about the z-axis

Abbreviations

A-E	Architect-Engineer
AM/FM	Automated Mapping/Facility Management
ANSI	American National Standards Institute
ASP	American Society of Photogrammetry
ASPRS	American Society for Photogrammetry and Remote Sensing
AWAR	Area Weighted Average Resolution
CADD	Computer-aided design and drafting
CF	Contour factor

CI	Contour interval
CONUS	Continental United States
COR	Contracting Officer's Representative
CRT	Cathode-ray tube
CW	Civil Works
DEM	Digital Elevation Modeling
DOT	U.S. Department of Transportation
DTM	Digital Terrain Model
EDM	Electronic distance measurement
F-hgt	Flight height
FAA	Federal Aviation Administration
FGCC	Federal Geodetic Control Committee
G&A	General and Administrative Overhead
GIS	Geographic Information System
GPS	Global Positioning System
IDT	Indefinite delivery type
IGE	Independent Government Estimate
JTR	Jount Travel Regulations
LIDAR	Light Detection And Ranging
LIS	Land Information System
MGE	Mean ground elevation
NAD 27	North American Datum of 1927 (for additional information, see <i>Datum</i> in paragraph B-3)
NAD 83	North American Datum of 1983 (for additional information, see <i>Datum</i> in paragraph B-3)
NAVD 88	North American Vertical Datum of 1988 (for additional information, see <i>Datum</i> in paragraph B-3)
NGRS	National Geodetic Reference System

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NGVD 29	National Geodetic Vertical Datum of 1929 (for additional information, see <i>Datum</i> in paragraph B-3)
NGS	National Geodetic Survey
OCONUS	Outside the continental United States
ODC	Other Direct Charges
OMB	Office of Management and Budget
QA	Quality assurance
QC	Quality control
QUAN	Quantity
RMSE	Root mean square error
SI	International System of Units
SPCS	State Plane Coordinate System
TIN	Triangulated irregular network
U/M	Unit measure
U/P	Unit price
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
USNMAS	U.S. National Map Accuracy Standards
UTM	Universal Transverse Mercator

Terms

Accuracy

Degree of conformity with a standard. Accuracy relates to the quality of a result and is distinguished from precision, which relates to the quality of the operation by which the result is obtained.

Adjustment

Process designed to minimize inconsistencies in measured or computed quantities by applying derived corrections to compensate for random or accidental errors.

Aerotriangulation (or Bridging)

The process of developing a network of horizontal and/ or vertical positions from a group of known positions using direct or indirect measurements from aerial photographs and mathematical computations.

Air Base

The line segment, or length of the line segment, joining two adjacent camera stations.

Airborne Global Positioning System

Airborne GPS employs on the fly surveys techniques for initialization of a receiver while it is in motion. This technique can be used to minimize the amount of ground control points required for aerotriangulation and mapping.

Analytical Stereoplotter

A digital optical Instrument system for plotting a map by observation of stereomodels formed by pairs of photographs. This type of system combines computer software and hardware with an optical viewing system. Film diapositives (hardcopy) of stereopairs is an integral part of an analytical stereoplotter.

Antivignetting Filter

A filter used with wide-angle photography to produce uniform lighting over the whole photograph.

Azimuth

Horizontal direction reckoned clockwise from the meridian plane.

Basic Control

A survey over the entire extent of a project that establishes monumented points of known horizontal position and monumented points of known elevation.

Bench Mark

Relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known.

Between-the-Lens Shutter

A shutter located between the elements of a camera lens.

Cadastral

Pertaining to extent, value, and ownership of land. Cadastral maps show property corners and property lines.

Calibration Plate

A glass photographic plate exposed in the aerial camera and developed to give a record of the relative positions of the fiducial marks (also called flash plate).

Camera Axis

A line through the camera rear nodal point, perpendicular to the film plane.

Camera Station

The point in space where the forward node of the camera lens was located at the instant the photographic exposure was made.

Cartography

Science and art of making maps and charts. The term may be taken broadly as comprising all the steps needed to produce a map: planning, aerial photography, field surveys, photogrammetry, editing, color separation, and multicolor printing.

C-factor and Assumed C-factor

Empirical ratio between flight height and contour interval used to indicate the capability of photogrammetric systems. (C-factor multiplied by contour interval desired equals flight height of aerial photography.) C-factor, unless otherwise indicated, is based on the use of 6-in. focal length lenses with a 9- by 9-in. film format.

Color Separation

Process of preparing a separate drawing, engraving, or negative for each color required in the printing production of a map or chart.

Comparator

A precise instrument that measures two-dimensional coordinates on a plane (usually a photograph).

Compilation

Process of drafting a new or revised map or chart, or portion thereof, from existing maps, aerial photographs, field surveys, and other sources.

Contact

A method of making copies of photography in which the photography is placed in contact with the photosensitive material during exposure, producing a copy of exactly the same size as the original.

Contour

Imaginary line on the ground, all points of which are at the same elevation above or below a specified datum.

Contour Interval (CI)

Difference in elevation between two adjacent contours.

Contouring Factor

The ratio of the flight height to the smallest contour interval that a photogrammetric system can consistently map to specification accuracy (also called C-factor).

Contrast

The difference between the densities of the lightest and the darkest areas of a photograph.

Control, Mapping

Points of established position or elevation, or both, used as fixed references in positioning and correlating map features. Fundamental control is provided by stations in the national networks of triangulation and traverse (horizontal control) and leveling (vertical control). Usually it is necessary to extend geodetic surveys, based on the fundamental stations, over the area to be mapped to provide a suitable density and distribution of control points.

Supplemental control points are those needed to relate the aerial photographs used for mapping with the system of ground control. These points must be positively photo identified; that is, the points on the ground must be positively correlated with their images on the photographs.

Control Station

Point on the ground whose position (horizontal or vertical) is known and can be used as a base for additional survey work.

Coordinates

Linear and/or angular quantities that designate the position of a point relative to a given reference frame.

Coordinates, Origin of

Point in a system of coordinates that serves as a zero point in computing the system elements or in prescribing its use.

Cover

In mapping, vegetation over the terrain.

Crab (Aerial Photography)

The condition caused by failure to orient the camera with respect to the track of the airplane. In vertical photography, crab is indicated by the edges of the photographs not being parallel to the ground track of the aircraft.

Culture

Features constructed by man under, on, or above the ground that are delineated on a map. These include roads, trails, buildings, canals, and sewer systems. In a broad sense, the term also applies to all names, other identification, and legends on a map.

Datum (Plural Datums)

In surveying, a reference system for computing or correlating the results of surveys. There are two principal types of datums: vertical and horizontal. A vertical datum is a level surface to which heights are referred. In the United States, the generally adopted vertical datum for leveling operations is the National Geodetic Vertical Datum of 1929. The horizontal datum, used as a reference for position, is defined by the latitude and longitude of an initial point, the direction of a line between this point and a specified second point, and two dimensions that define the spheroid.

Datum, National Geodetic Vertical

See National Geodetic Vertical Datum of 1929.

Deflection of the Vertical

At any point, the deviation of the vertical (plumb line) from the normal to the spheroid.

Develop

Subject an exposed photographic material to proper chemical solutions to change the latent image to a visible image.

Diapositive

A positive transparency for use in a precision photogrammetric instrument.

Diazo Process

Rapid and inexpensive method for reproducing documents.

Displacement

Any shift in the position of an image on a photograph resulting from tilt during photography, scale changes in the photographs, and relief of the area photographed.

Displacement Due to Relief

An essential characteristic of vertical aerial photography that causes high terrain points to appear farther from the center and low points to appear closer to the center of the photograph than would the map positions of the points.

Distortion

A lens aberration that causes a difference between the position of any part of the image and its theoretically correct position.

Dodging

Selectively shading or masking a portion of a photograph, while making a copy, to reduce extremes of contrast. Automatic dodging selectively varies illumination over the photograph in proportion to the average density of each area on the photography.

Doppler Effect

An apparent change in frequency of a signal caused by relative motion between the source and the point of observation.

Double Projection Stereoplotter

A stereoplotter in which the three-dimensional model is formed optically by projecting portions of the two photographs into the model space.

Easting

In a plane coordinate system, the coordinate that varies in a general east-west direction, increases to the east.

Electronic Distance Measuring (EDM) Devices

Instruments that measure the phase difference between transmitted and reflected or retransmitted electromagnetic waves of known frequency, or that measure the round-trip transit time of a pulsed signal, from which distance is computed.

Elevation

Vertical distance of a point above or below a reference surface or datum.

Emulsion

Suspension of a light-sensitive silver salt (especially silver chloride or silver bromide) in a colloidal medium (usually gelatin), which is used for coating photographic films, plates, and papers. Types of photographic emulsions commonly used are panchromatic (black and white), color negative, color positive, color infrared, and black-and-white infrared.

End Lap

Overlap of any two successive photographs in the direction of the flight line. Also called forward overlap.

Extraterrestrial Surveying System

A surveying system using radio signals from satellites that are received by receivers on monumented points and processed by computers to determine geodetic coordinates (longitude, latitude, and height above spheroid) of the occupied point. The two extraterrestrial surveying systems discussed in this manual are the Satellite Doppler System and the Global Positioning System.

Feature Separation

Process of preparing a separate drawing, engraving, or negative for selected types of data in the preparation of a map or chart.

Fiducial Marks

Reference marks formed on photography by marks held in a fixed relationship to the camera lens. The intersection of the lines connecting opposite fiducial marks usually defines the principal point of the photograph.

Fix

Render a developed photographic image permanent by chemical solutions that remove unaffected light-sensitive material.

Flight Altitude

The vertical distance of the aircraft above mean sea level.

Flight Height

The vertical distance from average terrain elevation to the point from which an aerial photograph is taken.

Flight Line

A line on the ground, on a map, or on vertical aerial photography designating the path along which the aircraft is to fly when photographing.

Flight Plan

All factors related to aircraft and camera operation contributing to producing suitable photography. A flight plan includes flight altitude, flight lines, and photograph spacing.

Focal Length

The distance from the rear nodal point of a lens to the plane on which the lens causes parallel rays of light to converge.

Fog (Photographic)

The visual reduction in light transmission caused by the base material (usually polyester) of the film plus the unexposed emulsion of the photographic medium.

Geodesy

Science concerned with the measurement and mathematical description of the size and shape of the earth and its gravitational field. Geodesy also includes the large-scale extended surveys for determining positions and elevations of points in which the size and shape of the earth must be taken into account.

Geodetic Coordinates

The position of a point described by latitude, longitude, and height above the ellipsoid.

Geodetic Survey

A survey that considers the surface of the earth to be curved.

Geoid

An equipotential surface coinciding with mean sea level for the oceans and extended in land areas so the surface is always perpendicular to the direction of gravity.

Global Positioning System

The GPS consists of the NAVSTAR satellites in six different orbits, five monitor stations, and the user community.

Graticule

Network of parallels and meridians on a map or chart.

Grid

Network of uniformly spaced parallel straight lines intersecting at right angles. When superimposed on a map, it usually carries the name of the projection used for the map—that is, Lambert grid, transverse Mercator grid, or universal transverse Mercator grid. However, care must be taken not to confuse a projection grid with the underlying network of geographic meridians and parallels (i.e., graticule) generated by the projection.

Halftone

A picture in which the gradation of light is obtained by the relative darkness and density of tiny dots produced by photographing the subject through a fine screen.

Imagery

Visible representation of objects and/or phenomena as sensed or detected by cameras, infrared and multispectral scanners, radar, and photometers. Recording may be on photographic emulsion (directly as in a camera or indirectly after being first recorded on magnetic tape as an electrical signal) or on magnetic tape for subsequent conversion and display on a cathode-ray tube.

Inertial Surveying

A total surveying instrumentation package using accelerometers, gyroscopes, and a computer to sense, compute, and record the three-dimensional position of the instrument as it is moved from point to point.

Interpretation

The result of stereoscopic examination of aerial photography augmented by other imagery to obtain qualitative information about the terrain, cover, and culture that might influence the location of a highway.

Intervalometer

A device that operates the camera shutter at a selected interval of time.

Latitude

Angular distance, in degrees, minutes, and seconds, of a point north or south of the equator.

Lens Distortion

Lens aberration shifting the position of images off the axis causing objects at different angular distances from the axis to undergo different magnifications.

Leveling

Surveying operation in which elevations of objects and points are determined relative to a specified datum.

LIDAR

Light Detection and Ranging. Laser range and distance measurements of the earth from an aircraft. Can be used to generate a dense grid of elevation points for various mapping products to include DEM, and DTM data sets.

Line Copy (Line Drawing)

Map copy suitable for reproduction without the use of a screen; a drawing composed of lines as distinguished from continuous-tone copy.

Longitude

Angular distance, in degrees, minutes, and seconds, of a point east or west of the Greenwich meridian.

Magazine

The part of an aerial camera that holds the film and includes the mechanism for advancing the film.

Map

Graphic representation of the physical features (natural, artificial, or both) of a part or the whole of the earth's surface, by means of signs and symbols or photographic imagery, at an established scale, on a specified projection, and with the means of orientation indicated.

Map, Engineering

Map showing information that is essential for planning an engineering project or development and for estimating its cost. It usually is a large-scale map of a small area or of a route. It may be entirely the product of an engineering survey, or reliable information may be collected from various sources for the purpose, and assembled on a base map.

Map, Flood Control

Map designed for studying and planning flood control projects in areas subject to flooding.

Map, Hypsographic

Map showing relief with elevations referred to a geodetic vertical datum.

Map, Landuse - Map showing the various purposes for which parcels of land are being used.

Map, Line

Map composed of lines as distinguished from photographic imagery maps.

Map, Orthophotographic

Map produced by assembling orthophotographs at a specified uniform scale in a map format.

Map, Planimetric

Map that presents only the horizontal positions for features represented; distinguished from a topographic map by the omission of relief in measurable form. The features usually shown on a planimetric map include rivers, lakes, and seas; mountains, valleys, and plains; forest and prairies; cities, farms, transportation routes, and public utility facilities; and political and private boundary lines. A planimetric map intended for special use may present only those features essential to the purpose to be served.

Map, Thematic

Map designed to provide information on a single topic, such as geology, rainfall, population.

Map, Topographic

Map that presents the horizontal and vertical positions of the features represented; distinguished from a planimetric map by the addition of relief in measurable form.

Map Projection

Orderly system of lines on a plane representing a corresponding system of imaginary lines on an adopted terrestrial or celestial datum surface; also, the mathematical concept of such a system. For maps of the earth, a projection consists of a graticule of lines representing parallels of latitude and meridians of longitude or a grid.

Map Series

Family of maps conforming generally to the same specifications and designed to cover an area or a country in a systematic pattern.

Mean Sea Level

The average of the heights of the surface of the sea at all stages of tide.

Meridian

A plane curve on the surface of the earth passing through the axis of rotation and any given point on the earth's surface. All points on a given meridian have the same longitude.

Monocomparator

A comparator that measures on a single photograph (see *comparator*).

Monument (Surveying)

Permanent physical structure marking the location of a survey point. Common types of monuments are inscribed metal tablets set in concrete posts, solid rock, or parts of buildings; distinctive stone posts; and metal rods driven in the ground.

Mosaic

An assembly of vertical aerial photographs to form a continuous representation of the terrain covered by the photography.

National Geodetic Vertical Datum of 1929

Reference surface established by the US Coast and Geodetic Survey in 1929 as the datum to which relief features and elevation data are referenced in the conterminous United States; formerly called "mean sea level of 1929."

Nodal Point

One of two intangible points in a camera lens that have the characteristic that any ray of light directed to the front nodal point will exit parallel to itself through the rear nodal point.

Northing

In a plane coordinate system, the difference between two positions as a result of movement to the north.

Oblique Photograph

A photograph taken with the axis of the camera intentionally directed between vertical and horizontal.

Origin of Coordinates

Point in a system of coordinates that serves as a zero point in computing the system's elements or in prescribing its use.

Orthophotograph

Photograph having the properties of an orthographic projection. It is derived from a conventional perspective photograph by simple or differential rectification so that image displacements and scale differences caused by camera tilt and terrain relief are removed.

Orthophotomap

An orthophotograph to which has been added a grid, contour lines, names, and/or other information characteristic of a map but missing on the orthophotograph.

Orthophotomosaic

Assembly of orthophotographs forming a uniform-scale mosaic.

Overlap

The amount by which one photograph overlaps another, customarily expressed as a percentage. The overlap between aerial photographs in the same flight line is called the end lap, and the overlap between photographs in adjacent parallel flight lines is called the side lap.

Overlay

A printing or drawing on a transparent or translucent medium intended to be placed in a register on a base map or other graphic. The overlay depicts information that does not appear on the base or require special emphasis.

Panchromatic

A photographic emulsion for black-and-white photography that is sensitive to all colors of the visible spectrum.

Parallax

An apparent change in the position of one object with respect to another because of a change in the position of observation.

Pass Point

A point whose horizontal and/or vertical position is determined from photographs by photogrammetric methods and is intended for use as a control point in the orientation of the photographs.

Photogrammetry

Science or art of obtaining reliable measurements or information from photographs or other sensing systems.

Photography

Photographic film, exposed and processed.

Photoindex

An assembly of photographs in their proper relative positions, generally annotated and copied at a reduced scale.

Photomap (Photographic Map)

Map made by adding marginal information, descriptive data, and a reference system to a photograph or assembly of photographs.

Plane Coordinate System

A system of usually perpendicular lines on a plane surface. Distances from the system to points on the surface represent coordinates.

Plane Survey

A survey that treats the surface of the earth as though it were a plane.

Planimetry

Plan details of a map—those having no indications of relief or contour (i.e., buildings).

Platen

The flat surface of an aerial camera against which the film is pressed while exposure is made.

Precision

The variance of repeated measurements from their average; the degree of refinement with which an operation is performed.

Principal Point

The foot of a perpendicular from the rear nodal point of the camera lens to the plane of a photograph.

Print

A copy made from a transparency by photographic means.

Process

Develop and fix exposed photographic material.

Quadrangle

Four-sided area, bounded by parallels of latitude or meridians of longitude used as an area unit in mapping (dimensions are not necessarily the same in both directions).

Rectification, Differential

The process of scanning and reprojecting small areas of a photograph onto a plane from different perspectives to remove displacements resulting from tilt and relief. The process may be accomplished by any one of a number of instruments developed specifically for the purpose.

Rectification, Simple

The process of projecting a photograph onto a horizontal plane by means of a rectifier to remove displacements resulting from tilt of the camera.

Relief

Elevation variations of the land or sea bottom.

Representative Fraction

Scale of a map or chart expressed as a fraction or ratio that relates unit distance on the map to distance measured in the same unit on the ground.

Root Mean Square Error (RMSE)

The square root of the quotient of the sum of the squares of the errors divided by the number of measurements, or

$$RMSE = \sqrt{(\sum e^2)/n}$$

in which e is the error at each point (the difference between the value used as a standard and the value being tested), and n is the total number of points tested.

Scale

The ratio of the size of the image or representation of an object on a photograph or map to its true size. Scale may be expressed as a representative fraction (as 1/10,000) or ratio (as 1:10,000) or it may be expressed as the number of feet to an inch. Scales are referred to as "large" if the ratio is large (the denominator is small) and as "small" if the ratio is small (the denominator is large).

Side Lap

Overlap of photographs in adjacent (parallel) flight strips.

Softcopy Workstation

Computer workstation for plotting a map by observation of stereomodels formed by pairs of photographs. These workstations differ from a stereoplotter because they do not require hard copy imagery in the system. Images are scanned and viewed in three dimensions on a high-resolution monitor with the aid of software and special glasses.

Spheroid

A surface easily defined mathematically that closely represents the geoid. It is produced by rotating an ellipse on its minor axis.

Spot Elevation

Point on a map or chart whose height above a specified datum is noted, usually by a dot or a small sawbuck and elevation value. Elevations are shown, on a selective basis, for road forks and intersections, grade crossings, summits of hills, mountains and mountain passes, water surfaces of lakes and ponds, stream forks, bottom elevations in depressions, and large flat areas.

State Plane Coordinate System

Coordinate systems established by the US Coast and Geodetic Survey (now the National Ocean Survey), at least one for each State.

Stereocomparator

A comparator using the binocular vision of the operator that measures the two photographs on a stereoscopic pair simultaneously (see *comparator*).

Stereocompilation

Drafting of a map or chart manuscript from aerial photographs and geodetic control data by means of photogrammetric instruments.

Stereoscopic

Pertaining to the use of binocular vision for observation of a pair of overlapping photographs or other perspective views, giving the impression of depth.

Supplemental Control

Surveys between basic control points to establish the additional points necessary to control the detailed mapping.

Target

A contrasting symmetrical pattern placed around a point on the ground to facilitate locating and measuring the image of the point in a photograph.

Target Map Scale

The intended design scale of the map or digital data file element.

Tilt

For vertical aerial photography, the angular deviation of the camera axis from a vertical line.

Topography

Configuration (relief) of the land surface; the graphic delineation or portrayal of that configuration in map form, as by contour lines; in oceanography the term is applied to a surface such as the sea bottom or a surface of given characteristics within the water mass.

Transparency

A photograph on a transparent (glass or plastic) base, which can be viewed by transmitted light.

Traverse

Sequence of lengths and directions of line segments connecting a series of stations, obtained from field measurements, and used in determining positions of the stations.

Triangulation

Method of extending horizontal position of the surface of the earth by measuring the angles of triangles and the included sides of selected triangles.

Trilateration

Method of surveying wherein the lengths of the triangle sides are measured, usually by electronic methods, and the angles are computed from the measured lengths.

Universal Transverse Mercator (UTM) Grid

Military grid system based on the transverse Mercator projection and applied to maps of the earth's surface extending from the Equator to the 84-deg latitudes.

Vertical Photograph

A photograph taken with the camera axis directed downward along (or nearly along) a vertical line.