



Exploration & Production

GENERAL SPECIFICATION

GEOMATICS

GS EP POS 008

Aerial Photogrammetric Survey

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1. Scope

The objective of this Specification is to provide reliable topographical maps when topographical data is acquired using aerial photogrammetric surveys conducted by companies within the TOTAL Group.

This Specification is to be used in conjunction with the other documents referred to in section 2 as well as the Scope of Work.

2. Reference documents

The reference documents listed below shall be considered by Contractor, as an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

All documents referred to in this section shall be considered as the latest versions and it shall be Contractor's responsibility to ensure that Contractor is in possession of these particular documents and that any qualifications are valid.

Standards

Reference	Title
ISO/TS 29001 : 2010	Quality management system requirements for the design, development, production, installation and service of products for the petroleum, petrochemical and natural gas industries, based on ISO 9001:2010

Professional Documents

The Positioning Contractor shall adhere to the following documents and ensure that they are available on the field and fully understood by the senior survey staff.

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	



Total General Specifications

Reference	Title
GS EP POS 003	Onshore Land Surveying & Positioning Works
GS EP POS 004	The use of Differential Global Positioning System
GS EP POS 007	Airborne Laser Scanning Survey (LiDAR)

3. Aerial Photogrammetric Survey - General Principles

Photogrammetry is the technique of measuring objects or earth features in two or three dimensions from photogram, also called stereo pairs of photographic images.

It is called a remote sensing technique insofar as the measurement device (the camera) is located at a distance, so that the objects or earth features can be measured without being touched.

Aerial photogrammetric surveys allow near-vertical images to be collected from an aircraft. The two photographs of each stereo pair are taken from two distinct positions of the aircraft.

An aerial photogrammetric survey is intended to provide different information types:

- Coordinates of the required objects and points
- Topographical and thematical maps
- Ortho rectified photographs (orthophotomaps).

A photographic image is a central perspective. This implies that every light ray, which reached the film surface during exposure, passed through the camera lens perspective centre.

Use of photographs to take precise measurements involves reconstructing the ray bundle. Therefore, the internal geometry of the used camera has to be precisely known.

A camera may be defined by its focal length, the position of the principal point and the lens distortion. The camera focal length is the distance of the projection centre from the image plane's principal point.

The aerial photogrammetry involves implementing a metric camera, characterized by a stable and precisely known internal geometry and a very low lens distortion, essential for precise measurements.

The focal length is constant, which means, that the lens cannot be sharpened when taking photographs. As a result, metric cameras are only usable within a limited range of distances towards the object. The image coordinate system is defined by (mostly) four fiducial marks, which are mounted on the frame of the camera.

If a large area is covered by overlapping photographs, the overlapping part of each stereo pair can be viewed in three dimensions and mapped accordingly using a photogrammetric stereo plotter.



4. Aerial Photogrammetry Limits

4.1 Weather Constraints

Irrespective of the aerial navigation weather constraints, clear visibility is essential to aerial photography.

No aerial photogrammetric survey shall occur in fog, rain, snow or dusty / sandy atmosphere (sand winds...) conditions.

Photographs shall be only taken when the visibility does not significantly impair the tone reproduction in the negative. Relevant details shall not be lost as a result of atmospheric haze, dust or atmospheric moisture. The survey area shall be completely free of clouds, dense large shadows or smoke.

4.2 Sun Elevation Treshold

Aerial photogrammetry relies on sun radiation. Acceptable lighting of the terrains to be photographed is essential. Any shadowed area will provide neither elevation nor planimetric information through the photogrammetric stereo plotting process.

As a result, shadowed areas will be excluded of the Digital Elevation Model, and relevant ground details may be poorly positioned or even left out of the charting. Should the survey be intended to provide large scale maps, any DEM blank areas will result in biasing the related longitudinal profile and cross sections.

Therefore, Company does not allow aerial photographs to be taken with a sun elevation below 30°.

Contractor shall provide corresponding calculations of sun elevations for the scheduled period of work in the survey area so as to settle the daily periods usable for survey.

Contractor shall note that the daily maximum acceptable survey duration degrades according to latitude and time interval to the winter solstice.

4.3 Operating Range

CONTACTOR shall make sure that the flight parameters comply with the aerial photogrammetry operating range.

For each survey area type (mountainous, urban, presence of high voltage power lines...), the flight height possible range shall be constrained by the aerial navigation safety regulations. These considerations shall lead to set a minimum possible flight height and photograph scale.

For mapping of very large areas at small scales, Contractor should rather consider implementing satellite high resolution imagery techniques.

4.4 Accuracy

The accuracy of the ground position for each detail displayed on the final maps is constrained by the survey parameters:

- Flight height
- Flight line straightness
- Camera metric quality

- Aerial films speed and quality
- Line Of Sight verticality (nadir orientation)
- Atmospheric clearness
- Shooting parameters (shutter speed, lens aperture, filtering)
- Ground registration frame scattering and quality
- Aircraft GPS kinematic processing position accuracy (if applicable).

Due to aerial navigation safety considerations, aerial photogrammetric survey can not be used for mapping at scales larger than 1/500 (flight height of 300 m).

When setting the survey parameters, Contractor shall make sure that they comply with the survey specifications in term of accuracy.

Contractor will also refer to [GS EP POS 007](#).

5. Stereo Preparation Works on the Ground

5.1 Geodetic Reference Network Land Survey

5.1.1 Network Definition

The aerial photogrammetric survey requires setting up a geodetic reference network on the ground, with points scattered through the whole survey area at regular spacing.

The reference network is to be used for land survey and tie-in of the ground control points / tics required for image registration and aero triangulation.

Besides this land survey, the reference network is liable to be used for setting up GPS equipment so as to derive the survey aircraft trajectory. If the aero triangulation process is to be carried out using GPS aiding to derive the photographs perspective centre, this option shall allow working out for every aerial photograph the spatial position of its perspective centre.

In this latter case, considering that the survey aircraft spatial position will be post-processed on the whole flight trajectory using dual frequency carrier phase DGPS implemented in kinematic mode from at least two (2) GPS reference stations, the spacing between adjacent stations shall not exceed 15 km.

If the aero triangulation process is to be carried out without any GPS aiding, spacing between network points shall only be fitted to the image registration frame scattering on the ground.

The geodetic reference network shall be surveyed using carrier phase DGPS implemented in post-processed static mode.

(Refer to General Technical Specification [GS EP POS 003](#) and [GS EP POS 004](#)).

5.1.2 Geodetic Tie-In

PLANIMETRY

The geodetic reference network shall be tied-in to the Project local geodetic datum so as to allow the photogrammetric stereo plotting to be carried out within this datum.

This tie-in may be carried out either applying datum shift parameters to be provided by Company or to be worked out using local trig points distributed through the Project area.



Alternatively, the network may be connected to the local trig points and adjusted within the Project datum (least squares adjustment constrained by trig points).

In other respects, should the aero triangulation process be GPS aided for deriving the perspective centre of each photograph, the geodetic reference network is first to be tied-in to the WGS-84 /ITRS reference system, even though the final post-processing still involves shifting the whole data set from WGS-84 into the Project horizontal and vertical datum.

(Refer to General Technical Specification **GS EP POS 003** and **GS EP POS 004**).

ELEVATION

In the same way, the network shall be tied-in to the Project vertical datum so as to derive a vertical reference surface, approximating the local geoid, in order to work out a function capable of shifting the whole WGS-84 ellipsoidal heights into orthometric elevations complying with the Project requirements.

Alternatively, the network may be connected to the local benchmarks and adjusted within the Project vertical datum (least squares adjustment constrained by benchmarks).

This tie-in shall be performed implementing geometrical (direct) levelling from local benchmarks distributed at regular spacing through the Project area. The geoid model reliability and accuracy will depend on the number and distribution of the levelled points.

5.2 Stereopreparation

5.2.1 Image Tics / Ground Controls Distribution

The image registration and aero triangulation process requires determining the ground position of sufficient tics / ground control points.

The number and distribution of these ground controls shall vary according to the survey area geometry (one or several adjacent runs), as described here after:

ISOLATED STEREO PAIR AREA

Any isolated stereo pair shall be fitted as follows:

- 1 ground control point to be surveyed in plane and height on every corner
- 2 ground control points to be determined in height on each one of the Line Of Flight and its parallels on both edges of the stereo pair.

STRIP AREA

Any strip (straight run) shall be fitted as follows:

- 2 distinct ground control points to be surveyed in plane and height on every corner
- 1 ground control point to be determined in plane every 3 stereoscopic pair on the whole strip perimeter
- 1 ground control point to be determined in height on every stereoscopic pair.

RECTANGLE BLOCK AREA

Any rectangle block made up of several strips shall be fitted as follows:

- 2 distinct ground control points to be surveyed in plane and height on every corner