



Exploration & Production

GENERAL SPECIFICATION

GEOMATICS

GS EP POS 004

The Use of Differential Global Positioning Systems

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Contents

1. Scope	4
2. Reference documents.....	4
3. General principles	5
3.1 Code phase pseudo range tracking.....	6
3.2 Phase-smoothed code tracking	6
3.3 Carrier phase tracking	6
4. Quality.....	7
4.1 Quality System.....	7
4.2 Quality Audits.....	8
4.3 Project quality plan	8
4.4 Quality Control Activity Plan	9
4.5 Documentation.....	9
5. Onshore geodetic control surveys	10
5.1 Definitions	10
5.2 General.....	10
5.3 Location and materialisation	11
5.4 Datum shift derivation	11
5.5 Elevation model	11
5.6 Operations	12
5.7 Processing	13
5.8 Report.....	13
6. Offshore DGPS positioning.....	14
6.1 Independent DGPS systems	14
6.2 Minimum requirements of an offshore DGPS service.....	15
6.3 Supply of a DGPS service	16
6.4 Utilisation of a DGPS service.....	16
7. Specific case of Real Time Kinematic positioning.....	19
7.1 RTK equipment specifications	19
7.2 Reference station requirements.....	19



7.3	Height definition and elevation model.....	20
8.	Glonass	20
Appendix 1	Definitions	21



1. Scope

The objective of this Specification is to provide reliable three dimensional positioning for operations conducted by companies within the Total Group. Contractor shall refer to the Scope of Work for the particular requirements of the project as well as the relevant Specification for the positioning of that type of project.

2. Reference documents

The reference documents listed below form 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 offshore and fully understood by the senior offshore survey staff.

Reference	Title
UKOOA Guidelines	Guidelines for the Measurement of Quality and Basic Quality Control of Offshore Positioning Data, published by the UKOOA Survey and Positioning Committee, June 1992
UKOOA Guidelines	Guidelines for the use of DGPS for offshore surveying. Guidelines documents published by UKOOA in October 1994
UKOOA P2/94	Recommended format for recording of raw offshore navigation data which is an extension of the existing P2/91 format with additional records for raw GPS data and associated pseudo-range corrections

Regulations

Reference	Title
Not applicable	



Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
Not applicable	

3. General principles

DGPS or Differential GPS is an enhanced concept based on the NAVSTAR Global Positioning System to minimize the errors in the measurement process and obtain higher accuracies. Also called Relative GPS, this consists on using two or more “reference” stations in order to compute real-time or post-processed corrections to apply on the “rover” station which needs to be located.

DGPS is a generic term that basically includes three different types of differential positioning:

- Code phase pseudorange tracking
- Phase-smoothed code tracking
- Carrier phase tracking.

These methods, either directly or indirectly, allow determining the range between a satellite and a ground-based receiver antenna, these measurements being made simultaneously at two or more different receiver stations. Either the satellite's carrier frequency phase or the phase of a digital code modulated on the carrier phase may be tracked, depending on the type of receiver. Through various processing techniques, the distance between satellites and receivers can be resolved and the relative positions of the two or more receiver points are derived. From these relative observations, a baseline vector between the stations is generated. The resultant positioning accuracy depends on the tracking method used, carrier phase tracking being more accurate than code phase tracking.

The term “corrections” in this specification refers to any computed data sent by one or various reference stations that allow increasing the accuracy of the mobile station. That may include standard RTCM corrections, satellites orbit and clock corrections, ionospheric or tropospheric corrections, etc.

3.1 Code phase pseudo range tracking

This is the most widely used differential GPS positioning technique, allowing to deliver meter level positioning accuracy from 0.1 m to 5 m depending on the receiver type and the DGPS reference network used.

Differential positioning using code C/A pseudo-range is performed similarly to the absolute positioning technique. However, some of the major clock error and atmospheric uncertainties are effectively minimized when simultaneous observations are made at two receiver stations.

The real time solutions used for E&P activities can be summarized as follows:

- Base station ownership using HF, VHF or UHF broadcasted corrections. They are generally single-frequency C/A receivers with RTCM SC-104 data transfer format or proprietary format. Example of receiver: Sercel NR203
- Coastal DGPS solutions: DGPS beacons are deployed alongside the coast to broadcast corrections up to 200 km. This technique is operated, for example, by CETMEF in France, the coast guards is US and the General Lighthouse Authorities in Great Britain where the whole onshore area is covered by these DGPS stations
- Wide-Area DGPS technique: Numerous worldwide stations transmit GPS measurements and corrections to Network Control centres. While gathered, computed and checked for integrity, the reference data is up-linked to a series of L-band geostationary satellites, and then broadcasted to users. Examples of receivers: Omnistar and Starfix series (HP, XP and VBS services) or C&C C-Nav systems (also called GcGPS)
- The Satellite-Based Augmentation Systems (SBAS): Three similar systems coexist: EGNOS (European geostationary Overlay Service) for Europe, WAAS (Wide Area Augmentation System) for US and MSAS (MT SAT Augmentation System) for Japan.

3.2 Phase-smoothed code tracking

Also called EDGPS for Enhanced DGPS, this technique consists in using both measures of pseudo-range and phase corrections in real time or post process using one reference station and one rover. Example of receiver: Thales Navigation Sagitta.

3.3 Carrier phase tracking

This is the most accurate processing solution where L1 (/L2) carrier phase measurements are performed further to pseudorange only for the DGPS techniques seen above.

Two stations are required, where one is generally located above a reference control point and the other in movement or over a point to geo-reference.

Carrier phase tracking provides an accurate satellite-receiver range resolution due to the short carrier wavelengths and the ability of a receiver to resolve the carrier phase down to few millimetres. This may be employed in both static and cinematic modes, which have similar observation and initialization requirements, and differs mainly in the initialization procedure and whether the positioning computations are performed in real time or post processed.

The different modes can be summarized as follows:

- Static: It involves long observation time in order to resolve the integer ambiguities between the satellite and the receiver. Accuracies in sub-centimetre range can be obtained using either single-frequency or dual-frequency receivers

- **Rapid static:** Used to measure baselines and determine positions at the centimetre level with short and static observation times (between 5 and 20 minutes)
- **Post-Processed Kinematic:** This mode allows the user to rapidly and accurately measure baselines while moving from one point to the next, stopping briefly or in dynamic motion. A reference receiver is set up at a known control point whereas the rover traverses between the unknown points to be positioned. The data is collected and post-time processed to obtain accurate positions to the centimetre level. This technique also requires some form of initialization to resolve the carrier phase ambiguities
- **Stop & Go Kinematic:** This involves collecting static data for several minutes (between 10 and 30 minutes) at each station after a period of initialization to gain the integers. This doesn't allow for loss of satellite lock during the survey otherwise a new period of initialization must take place
- **Real Time Kinematic:** This positioning method will yield sub-decimetres accuracies in real-time by determining the integer number of carrier wavelengths between the satellite and the receiver while the rover receiver is in motion (On The Fly) and without static initialization. A communication link is required between the reference and the rover receivers.

A reference receiver, located at the work site, henceforth refers to as Reference Station(s) which has co-ordinates determined in the WGS84 global reference system from the current issue of the ITRF adopted by the IGS at epoch of measurement (henceforth referred as ITRF).

A remote GPS receiver shall be installed on the object to be positioned, whether vessel, mobile drilling rig, unknown point etc. The reference station shall compute differential pseudo-range corrections for all GPS satellites in view. These corrections shall then be transmitted to the remote station, ensuring that the age of corrections is no greater than required by the positioning task. The remote receiver (or positioning computer interfaced to it) shall then apply the corrections to the observed pseudo-ranges before computing its position.

4. Quality

4.1 Quality System

The Contractor shall be managed by an effective Quality System that ensures conformance to agreed requirements of the project.

The system shall provide verified and traceable documentation showing compliance with the project requirements.

The requirements of [ISO/TS 29001](#) shall be met.

The Quality System shall comprise the:

- Quality Assurance Procedure Manual
- Project Quality plan
- Work Instructions and Standard Procedures
- Records, Reference and Support Documentation.

These shall be in the English language and available for audit by Company.