

Georeferenced Topographic Survey

Procedure

This Standard replaces and cancels its previous revision.

The CONTEC - Authoring Subcommittee provides guidance on the interpretation of this Standard when questions arise regarding its contents. The Department of PETROBRAS that uses this Standard is responsible for adopting and applying the sections, subsections and enumerates thereof.

Technical Requirement: A provision established as the most adequate and which shall be used strictly in accordance with this Standard. If a decision is taken not to follow the requirement ("non-conformity" to this Standard) it shall be based on well-founded economic and management reasons, and be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by imperative nature.

Recommended Practice: A provision that may be adopted under the conditions of this Standard, but which admits (and draws attention to) the possibility of there being a more adequate alternative (not written in this Standard) to the particular application. The alternative adopted shall be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by verbs of a nonmandatory nature. It is indicated by the expression: **[Recommended Practice]**.

Copies of the registered "non-conformities" to this Standard that may contribute to the improvement thereof shall be submitted to the CONTEC - Authoring Subcommittee.

Proposed revisions to this Standard shall be submitted to the CONTEC - Authoring Subcommittee, indicating the alphanumeric identification and revision of the Standard, the section, subsection and enumerate to be revised, the proposed text, and technical/economic justification for revision. The proposals are evaluated during the work for alteration of this Standard.

"This Standard is exclusive property of Petróleo Brasileiro S. A. - PETROBRAS, internal application and PETROBRAS Subsidiaries and shall be used by its suppliers of goods and services under contracts or similar under the conditions established in Bidding, Contract, Agreement or similar.

The use of this Standard by other companies / organizations / government agencies and individuals is the sole responsibility of the users.."

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Introduction

PETROBRAS Technical Standards are prepared by Working Groups - WG (consisting specialized of Technical Collaborators from Company and its Subsidiaries), are commented by Company Units and its Subsidiaries, are approved by the Authoring Subcommittees - SCs (consisting of technicians from the same specialty, representing the various Company Units and its Subsidiaries), and ratified by the Executive Nucleus (consisting of representatives of the Company Units and its Subsidiaries). A PETROBRAS Technical Standard is subject to revision at any time by its Authoring Subcommittee and shall be reviewed every 5 years to be revalidated, revised or cancelled. PETROBRAS Technical Standards are prepared in accordance with PETROBRAS Technical Standard N-1. For complete information about PETROBRAS Technical Standards see PETROBRAS Technical Standards Catalog.

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Foreword

This Standard is the English version (issued in 04/2014) of PETROBRAS N-47 REV. J 04/2012. In case of doubt, the Portuguese version, which is the valid document for all intents and purposes, shall be used.

1 Scope

1.1 This Standard specifies the required conditions supplementing ABNT [NBR 13133](#) or the performance of georeferenced topographic survey services.

1.2 This Standard specifies the required conditions for installation of deep level references (Benchmark).

1.3 Services to be performed with support of GNSS stations shall follow PETROBRAS [N-2698](#).

1.4 This Standard applies to designs started as of their date of issuance.

1.5 This Standard contains only Technical Requirements.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

Ministério do Desenvolvimento Agrário (MDA) - [Norma Técnica para Georreferenciamento de Imóveis Rurais](#);

PETROBRAS [N-381](#) - Execution of Drawing and Other General Technical Documents;

PETROBRAS [N-845](#) - Geotechnical Investigation;

PETROBRAS [N-1041](#) - Cadastramento de Imóveis em Levantamento Topográfico-Cadastral;

PETROBRAS [N-2200](#) - Sinalização de Dutos, Faixa e Área de Domínio de Duto e Instalação Terrestre de Produção;

PETROBRAS [N-2698](#) - Elaboração de Serviços Georreferenciados;

PETROBRAS [N-2726](#) - Dutos;

PETROBRAS [N-2908](#) - Dados Ambientais Georreferenciados;

ABNT [NBR 6484](#) - Solo - Sondagens de Simples Reconhecimentos com SPT;

ABNT [NBR 13133](#) - Execução de Levantamento Topográfico.

NOTE For documents referred in this Standard and for which only the Portuguese version is available, the PETROBRAS department that uses this Standard should be consulted for any information required for the specific application.

3 Terms and Definitions

For the purposes of this document, the following terms and definitions of ABNT [NBR 13133](#), PETROBRAS [N-2698](#) and [N-2726](#) apply, supplemented by the conditions described in 3.1 to 3.17.

3.1

azimuth

horizontal angle measured in the clockwise direction from north to the reference alignment

3.2

“benchmark”

deep level reference

3.3

meridian convergence

relationship between the true azimuth (in reference to the true north) and the grid azimuth (in reference to the north of the grid)

3.4

“DATUM”

Surface reference for horizontal (X, Y) and vertical (Z) control of points

3.5

magnetic declination

variable angle formed between the magnetic meridian and the geographic or astronomic meridian of the Earth

3.6

georeferencing

Assignment of geodetic coordinates to the elements setting the boundaries of properties and rights of way

3.7

magnetic north

site in the North-South direction, whose direction points at the northern magnetic pole of the Earth, that is, it is the direction indicated by the needle of a compass in the absence of friction and local sources of attraction

3.8

grid north

direction perpendicular to the equator on cartographic plans

3.9

true north

the direction of the geographical north pole of the Earth

3.10

support polygonal

polygonal which has the goal of conveying coordinates and altitudes from basic support stations to the relevant vertices of the principal polygonal

3.11**principal polygonal**

polygonal that serves as support and planialtimetric control for all surveys to be carried out in the area or strip

3.12**secondary polygonal**

Polygonal which has its origin and its end on the vertices of the principal polygonal

3.13**restitution**

stage in topographic survey consisting of plotting an area or strip in planialtimetry, to a uniform scale, by using photogrammetric methods or direct field survey

3.14**Deep Level Reference (DLR)**

unsettlable fixed point used for control of settlements

3.15**Reference Geodesic System for South America (SIRGAS 2000)**

official reference system of "DATUM"

3.16**topo-bathymetry**

determination of the relief of the bottom of a river, lake or sea

3.17**"Global Navigation Satellite System (GNSS)"**

system capable of locating the coordinates of a point based on the information conveyed on the electromagnetic waves of a network of satellites

4 General Conditions

For the purposes of this Standard, the general conditions set out in ABNT [NBR 13133](#) and PETROBRAS [N-2698](#) are adopted, as well as the general considerations indicated in the [Technical Standard for Georeferencing of Rural Properties](#), complemented by 4.1 to 4.8.

For geotechnical services for installation of DLR, the conditions set out in PETROBRAS [N-845](#) are adopted.

4.1 Execution Procedure

The execution procedure for georeferenced topographic surveys shall contain at least the following information:

- a) objective: definition of the basic goal of the survey;
- b) applicable standards and documents;
- c) terms and definitions;
- d) equipment used;
- e) definition of basic support network;
- f) topographic references (type and usage);

- g) tolerances;
- h) methodology for performance of services;
- i) results of services;
- j) safety, occupational health and environmental requirements;
- k) technical staff employed in the execution of services.

4.2 Equipment

4.2.1 All measurement devices shall be in perfect order, shall be periodically calibrated and gauged, and their accuracy shall be compatible with established tolerances. The gauging and calibration certificate is not applicable to the GNSS.

4.2.2 In addition to the equipment mentioned in the ABNT [NBR 13133](#), the GNSS shall be included as basic equipment for locating planimetric and altimetric coordinates.

4.2.3 The gauging and calibration certificate for the devices shall be valid for up to six months as of their date of issuance.

4.3 Basic Support

4.3.1 The georeferenced topographic survey shall refer to the Brazilian Geodesic System (SGB).

4.3.2 At the option of PETROBRAS, another "DATUM" may be adopted, and the transformation parameters for this "DATUM" are defined by PETROBRAS.

4.3.3 All selected horizontal and vertical support stations shall be previously checked "in situ" in consultation with the respective agencies, and they shall be materialized and described through papers containing at least the information outlined in 4.4.1.3.

4.3.4 The coordinates and altitudes shall be transported as far as the areas and strips through support polygonals with accuracy equal to or greater than that determined by the design for the principal polygonal.

4.4 Topographic References

4.4.1 Topographic Markers

At least two topographic markers shall be installed at sites chosen by PETROBRAS. These markers shall allow for reciprocal sightings and shall comply with the tolerance limits set forth in 4.8. Type A intermediate topographic markers shall be installed on the rights of way at every 5 km.

4.4.1.1 Types of Markers

Depending on the goal that they are designed to achieve, the topographic markers shall fall into the following categories:

- a) type "A" markers (40 kg) - as per Figure A.1 of Annex A of this Standard;
- b) type "B" markers (750 kg) - as per Figure A.2 of Annex A of this Standard;
- c) type "C" markers (200 kg) - as per Figure A.3 of Annex A of this Standard;
- d) DLR markers - as per Figure A.4 of Annex A of this Standard.

4.4.1.2 Use of Markers

- a) type "A" markers - these shall be used in the basic design phase, study phases of the basic route, implementation of the definitive route, and intermediate markers in pipeline right of way;
- b) type "B" markers - these shall be used in the implementation phase of the definitive design of the areas or extremities and branches of strips;
- c) type "C" markers - are an option to type "B"; they are lighter and shall be installed at points to be selected at the option of PETROBRAS;
- d) DLR markers - these shall be used in sites subject to settlement, with a view to ensuring the reliability of the reference, where the installation of other types of markers is not recommended.

4.4.1.3 Identification of Markers and Contents of their Geodetic Monographs

4.4.1.3.1 Topographic markers of types A, B and C shall be identified through bronze or stainless steel plates containing the information indicated on the detail of Figure A.3

4.4.1.3.2 Monographs of topographic markers of types A, B and C shall contain at least the following information:

- a) numbering of marker;
- b) altitude and coordinates in the UTM (Universal Transverse Mercator) and geographic systems, in "DATUM" SAD 69, SIRGAS 2000;
- c) sketches showing location and description of access;
- d) date of implementation and person responsible for execution.

4.4.1.3.3 For DLR markers, a installation report shall be presented, comprising a descriptive part, a location drawing, and a schematic profile drawing of the installation.

4.4.1.3.4 In the descriptive part of DLR markers, there shall be all information about the sounding performance, driving of DLR, and other notes.

4.4.1.3.5 In the location drawing of DLR markers, it shall be provided the coordinates and elevation of DLR head.

4.4.1.3.6 In the schematic profile drawing for installation of DLR, it shall be provided all pipe installation elevations, indicated on the side of the respective sounding profile performed.

4.4.1.4 Location of Markers

4.4.1.4.1 Topographic markers of types A, B and C shall be installed in accessible sites which are safe from the point of view of their preservation. All the vertices of the principal polygonal which coincide with the vertices of the secondary polygonal, extremities of strips and any other point of interest for planimetric and altimetric reference shall be materialized through topographic markers. In pipeline right of way, markers shall be installed within the right of way, on its side, whenever possible.

4.4.1.4.2 The installation location for DLR markers shall be selected according to:

- a) points which settlements are to be measured, so as it is necessary the smallest number of auxiliary pickets to read the settlements;

- b) the sounding report of the area adjacent to the work, and preferably out of vehicle traffic areas or works in progress.

4.4.1.5 Seating and Specification of Markers

4.4.1.5.1 When seating the markers, attention shall be paid to their foundation conditions, so as to prevent any possible displacements.

4.4.1.5.2 DLR shall be installed through a geotechnical percussion sounding hole, with coating pipe of $\varnothing 2\frac{1}{2}$ " or $\varnothing 3$ ", performed in accordance with ABNT [NBR 6484](#) and PETROBRAS [N-845](#).

4.4.1.5.3 DLR shall be made of two concentric galvanized steel pipes. The external pipe of $\varnothing 2\frac{1}{2}$ " or $\varnothing 3$ " - coating - is intended to protect the internal pipe of $\varnothing 1$ " - stem -, as indicated in Figure A.4 of Annex A.

4.4.1.5.4 The DLR stem shall have its lower extremity (seating elevation) seated on the elevation corresponding to the impenetrable area obtained in the coating installation, or if percussion strength rates equal to or above 30/30 are obtained in the last 4 m.

4.4.1.5.5 The lower extremity of the coating pipe shall be at least 1,50 m above the stem seating elevation.

4.4.1.5.6 The annular space between the 2 pipes shall be filled with anti-corrosion graphite grease.

4.4.1.5.7 It shall be injected through the stem, under pressure, a cement slurry with water/cement content of 0,5 (five tenths) which shall overflow to the ground through holes located in the stem edge, so that it allows the formation of a wide base, fixing the stem on ground, and other stem fixation techniques may be used. That cement slurry shall fill all the inner part of the stem, until its upper extremity.

4.4.1.5.8 The DLR head shall be protected by a reinforced concrete box, or by a shackle, concrete or steel pipe, as indicated in Figure A.5 of Annex A.

4.4.1.5.9 The DLR head consists of a half sphere of brass, pasted with epoxy in a stem top closing plug, which works as a support for the sight.

4.4.1.6 Preservation of Topographic Markers

- a) preservation of type A, B, and C topographic markers buried 20 cm below ground level (see Figure A.6 of Annex A) is:
- mandatory for markers installed on rights of way;
 - at the option of PETROBRAS for markers installed in the other external areas;
 - not applicable to internal areas;
- b) preservation of topographic markers with the installation of three concrete blocks for signaling (see Figure A.6 of Annex A) shall be adopted for all types of markers and at all facilities. The blocks shall be painted in yellow on all sides according to the general conditions contained in PETROBRAS [N-2200](#).