



Exploration & Production

GENERAL SPECIFICATION

SURVEYS

GS GEO 101

Offshore geotechnical soil survey

02	10/04	Revised § 2
01	09/03	Change of Group name and logo
00	03/01	First issue
Rev.	Date	Notes

Contents

1. Scope	3
2. Reference documents.....	3
3. Units	5
4. Geotechnical survey vessel	6
4.1 General documentation	6
4.2 Positioning	6
4.3 Drilling equipment and procedures	7
5. Soil sampling equipment and procedures	8
5.1 Seabed surface sampling	8
5.2 Deep bottom-hole sampling.....	8
6. In-situ test equipment and procedures	9
6.1 Standard static cone penetration test (CPTU)	9
6.2 Other in-situ tests.....	11
6.3 Presentation of results	12
7. Laboratory test equipment and procedures	12
7.1 Laboratory tests performed onboard the survey vessel.....	12
7.2 Laboratory tests performed onshore.....	13
8. Evaluation and presentation of geotechnical parameters.....	14
8.1 Soil conditions and geotechnical parameters	14
8.2 Geotechnical and foundation engineering	14
8.3 Database	15
9. Reports to be submitted by the CONTRACTOR	15
9.1 Field report.....	15
9.2 Final geotechnical survey report.....	16
10. Quality assurance and safety procedures	17
10.1 Quality assurance	17
10.2 Safety and the CONTRACTOR's responsibility	17
10.3 Inspection and acceptance of the survey vessel	18

1. Scope

The document, giving the minimum requirements applicable to the equipment and procedures for offshore geotechnical soil surveys, defines standards and references for obtaining satisfactory and consistent quality in offshore soil investigations. It applies to:

- The geotechnical survey vessel and onboard drilling equipment
- The equipment and procedures for soil sampling and in-situ soil testing
- The procedures for laboratory tests on soil samples, both onboard the vessel and onshore
- The evaluation and processing of the geotechnical data to determine the soil characteristics and parameters required for the design of the foundations for the intended structure(s)
- The safety of offshore site operations and the CONTRACTOR's responsibility.

In addition, Particular Technical Specifications shall apply when more detailed references are required, and the geotechnical survey works shall be performed in accordance with the Agreement signed between COMPANY and CONTRACTOR.

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.

Standards

Reference	Title
ISO 1000	Specification for SI Units and Recommendations for the Use of their Multiples and of Certain Other Units
ISO 9001	Quality Systems – Model for Quality Assurance in Design, Development, Production, Installation and Servicing
ISO 13623	Petroleum and Natural Gas Industries – Pipeline Transportation Systems
ISO DIS 19900	International Standard for Offshore Structures – Part 1: General Requirements – Part 1-4: Geotechnical and Foundation Design Considerations
ISO 14688-1	Identification and Classification of Soil
ISO 14689-1	Identification and Classification of Rock
CEN ENV 1997 Eurocode 7	Geotechnical Design – Part 1: General Rules - Part 2: Laboratory Testing - Part 3: Field Tests
CEN ENV 1998-5 Eurocode 8	Design Provisions for Earthquake Resistance of Structures - Part 5: Foundations, Retaining Structures and Geotechnical Aspects
BS 5930	Code of Practice for Site Investigations
BS 1377, Parts 1 to 9	Methods of Tests for Soils for Civil Engineering Purposes

Reference	Title
BS 8004	Code of Practice for Foundations
BS 8010, Part 3	Pipelines Subsea: Design, Construction and Installation
BS 6349	Code of Practice for Maritime Structures - Part 2: Design of Quay Walls, Jetties and Dolphins
NS G-CR-001	Common Requirements for Marine Soil Investigations
NS 3481	Soil Investigation and Geotechnical Design of Marine Structures
NS 8000	Geotechnical Testing – Laboratory Methods
NF P 94	Soils: Surveys and Tests
ASTM Standards Volume 04.08	Construction, Soil and Rock; Building Stones

Professional Documents

Reference	Title
API RP 2A	Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design & Load and Resistance Factor Design
API RP 2SK	Recommended Practice for Design and Analysis of Stationkeeping Systems for Floating Structures
API RP 2FP1	Recommended Practice for Design, Analysis and Maintenance of Moorings for Floating Production Systems
API RP 2T	Recommended Practice for Planning, Designing and Constructing Tension Leg Platforms
API RP 2N	Recommended Practice for Planning, Designing and Constructing Pipelines for Arctic Conditions
ISSMGE	International Society For Soil Mechanics and Geotechnical Engineering. International Reference Test Procedure for the Cone Penetration Test (CPT) and the Cone Penetration Test with Pore Pressure (CPTU) - Report of the Technical Committee 16 on Ground Property Characterisation from In-Situ Testing (1999)
USCS	Unified Soil Classification System. Waterways Exp. Station Corps of Engineers, US Army. Technical Memorandum No. 3-357, Vols. 1 to 3 (1953)
ISRM	International Society for Rock Mechanics. Rock Characterisation Testing and Monitoring – ISRM Suggested Methods (1981)
SOLAS 74/78/81/83	International Maritime Organisation. International Conventions for the Safety of Life at Sea

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS GEO 110	Requirements for Offshore Survey Vessels
GS GEO 201	Offshore Geophysical Survey
GS GEO 202	Geophysical Survey for Offshore Pipelines Installation
GS GEO 301	Offshore Surface Positioning Works
GS GEO 701	Geotechnical data and foundation design considerations for subsea production systems and pipelines
GS GEO 702	Requirements for design and installation of skirted foundations and suction anchors
GS GEO 703	Requirements for design and installation of drag anchors and anchor piles for offshore floating structures
GS STR 431	Installation of Piles for Offshore Steel Structures. Driving
GS STR 432	Installation of Piles for Offshore Steel Structures. Drilled and grouted piles

3. Units

Only the ISO international system of units (ISO 1000) shall be used. However, the standard diameter and wall thickness of steel tubular pipes can also be expressed in inches (1 inch = 25.4 mm). When this is the case, the symbol used for the inch unit (" or in.) shall be clearly indicated.

4. Geotechnical survey vessel

4.1 General documentation

The CONTRACTOR shall supply the following general documentation about the geotechnical survey vessel (to be in agreement with **GS GEO 110**):

- Copy of vessel certificates (original documents to be provided at COMPANY's request)
- Dimensions, main characteristics, accommodations, etc.
- Bunker capacity (fuel, potable water, food, consumables, etc.), for allowing to perform the complete geotechnical survey without port call,
- Methods of communication (VHF and BLU radio, SATCOM facilities, etc.)
- Helideck (if any)
- Equipment and procedures for mooring and/or dynamic positioning
- Drilling equipment (derrick, power swivel, equipment for heave motion compensation, seabed frame, mud pumps, drill string and bits) and sampling equipment
- Equipment and procedures for measuring the environmental conditions, including water depth, surface and sea bottom current, and wind speed
- Equipment and procedures for surveying the sea bottom, in the event that there are subsea wellheads or other obstacles to be identified on the work site
- Onboard test laboratory
- List of references of previous jobs using the proposed survey vessel, and marine crew experience.

A survey vessel without dynamic positioning shall have at least four mooring points and shall be able to anchor alone. In the event that assistance from an anchor handling ship is required, this shall be mentioned by the CONTRACTOR, as well as the characteristics this vessel requires.

The vessel's Master and Mate shall be specifically trained or experienced with offshore survey works. They shall be fluent in English, and their Curriculum Vitae shall be provided by the CONTRACTOR, together with those from other key personnel (see section 10).

4.2 Positioning

Unless otherwise indicated in the Particular Technical Specifications, positioning of the survey vessel at the geotechnical boring locations shall be the responsibility of the CONTRACTOR, including supply of the equipment and personnel needed to work 24 hours a day throughout the period of offshore works.

The positioning equipment and procedures shall be in accordance with General Specification **GS GEO 301** regarding offshore surface positioning works.

Positioning shall be carried out with a satellite-based positioning system with onshore or offshore reference stations (DGPS system), providing accurate real time positioning information. A complete description of the positioning system shall be included in the CONTRACTOR's technical documentation.

The positioning system shall be checked before commencement of the offshore works, by means of:

- A check along quayside relative to a fixed point with known co-ordinates, and/or
- A check at sea, by transit fixes around a fixed platform with known geographical and grid co-ordinates.

In the event that any doubt remains about the accuracy of the positioning system, this check shall be repeated at COMPANY's request on completion of the survey works, before the vessel is demobilised.

If there are wellheads or any other obstructions present on the seabed near the survey points, a location map will be provided by the COMPANY. These wellheads or other obstructions shall be clearly identified prior to commencement of the geotechnical survey works.

4.3 Drilling equipment and procedures

The documentation concerning the drilling equipment and procedures shall include:

- Dimensions, weight and general characteristics of the seabed frame
- Characteristics of the drill string, including drill bits, drill collars and pipes (steel or aluminium pipes)
- Characteristics of the system for preparing and circulating the drilling mud, and type of drilling mud
- System of heave motion compensation, for both the seabed frame and the drill string
- Procedures for operating the sampling and in-situ testing equipment through the drill string.

In deep water (more than 500 metres), the seabed frame shall include a positioning beacon. Additional instrumentation (such as sea bottom current meter, tilt meter, and video camera, etc.) shall be provided in accordance with the Particular Technical Specifications.

In case of possible soft soils on the sea bottom, a stability assessment for the seabed frame shall be supplied by the CONTRACTOR, including an estimate of possible settlement during operations. If needed, the means required (e.g. skirts, lightening of the frame, or other) to reduce such settlement shall be considered.

In accordance with the Particular Technical Specifications, the drilling equipment and procedures shall be designed for the various types of soil conditions likely to be encountered. The drilling procedures shall be such that the risk of disturbing the soil to be sampled or tested in-situ is minimised.

The drilling parameters shall be monitored and recorded, including the following parameters: drilling rate (drilling time in minutes per metre drilled, or metres drilled per hour), weight on drill bit, torque and mud pressure.

The intended penetration of geotechnical borings is given in the Particular Technical Specifications. The CONTRACTOR shall be prepared to achieve at least fifty percent more than this planned penetration depth with the available equipment and consumables.

Depending on the geophysical site survey data available, the possible risk of occurrence of shallow gas is mentioned in the Particular Technical Specifications. If such a risk exists, the safety equipment and procedures for monitoring and controlling shallow gas kicks during drilling

(including heavy mud, individual detection and protection systems for personnel, etc.) shall be defined in co-operation between CONTRACTOR and COMPANY.

5. Soil sampling equipment and procedures

As indicated in the Particular Technical Specifications, and depending on the objectives of the geotechnical survey mentioned by the COMPANY, the equipment required to perform seabed surface or bottom-hole sampling operations shall be supplied by the CONTRACTOR, and the equipment and procedures shall be capable of sampling operations in all soil conditions likely to be encountered.

5.1 Seabed surface sampling

Seabed surface sampling consists in recovering samples taken from the sea bottom. Depending on the expected soil conditions and the required depth of sampling mentioned in the Particular Technical Specifications, different types of corer shall be proposed by the CONTRACTOR, including:

- Grab sampler, for recovering disturbed samples of sediments from the seabed
- "Kullenberg" type gravity corer, or gravity corer with internal liner and stationary piston
- Vibro-corer, or other types of corer.

For this seabed surface sampling equipment, the CONTRACTOR's technical documentation shall include:

- Main dimensions (length, internal and external diameter) and characteristics of the corer (weight, core catcher, type of internal liner, whether a stationary piston is used, etc.), as well as any instrumentation required to record the corer's position on the seabed
- System of penetration (i.e. by free fall, dead weight, vibration, driving, or other), specifying the ancillary equipment required (power unit, etc.)
- System used to handle the corer (i.e. derrick, crane, A-frame, winch, or other)
- Procedure for extruding and storing the recovered samples
- List of previous jobs performed with the proposed type of corer, including: core barrel length, recovery, maximum depth of penetration into the soil, estimate of the quality of the samples recovered, maximum water depth, and average operating times (depending on water depth and soil conditions).

When a seabed frame is used with this surface sampling equipment, and in case of possible soft soils on the seabed, a stability assessment shall be supplied by the CONTRACTOR.

5.2 Deep bottom-hole sampling

Deep bottom-hole sampling consists in taking samples by means of tools operated through the drill string. Depending on the expected soil conditions mentioned in the Particular Technical Specifications, different types of corer shall be proposed by the CONTRACTOR, including:

- Hydraulic push sampler, with or without stationary piston
- Driven (hammer) sampler
- Rotary coring system, for cemented soils and rocks.

For this deep bottom-hole sampling equipment, the CONTRACTOR's technical documentation shall include:

- Dimensions (length, internal and external diameter) and main characteristics of the corer (core catcher, type of internal liner, whether a stationary piston is used, etc.)
- For a hydraulic push sampler: the maximum hydraulic thrust force available
- For a driven sampler: the weight and height of free fall of the striking ram
- For a rotary corer: type of drill bit, length and diameter of drill pipes, dimensions of core barrel and of samples recovered, method of operation (i.e. "piggy-back"-type or other)
- Procedure for extruding and storing the recovered samples
- List of previous jobs performed with the proposed type of corer, including: maximum water depth, maximum depth of penetration into the soil, estimate of the quality of the samples recovered, and average operating times (depending on water depth and soil conditions).

6. In-situ test equipment and procedures

As indicated in the Particular Technical Specifications, and depending on the objectives of the geotechnical survey mentioned by the COMPANY, the equipment required to perform seabed surface or deep bottom-hole in-situ tests shall be proposed by the CONTRACTOR.

6.1 Standard static cone penetration test (CPTU)

The static cone penetration test with pore pressure (CPTU test) is the reference in-situ test. The cone geometry and test procedure shall comply with the international reference test procedure of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE, 1999).

The electric penetrometer probes shall allow for continuous recording (that is at least one measurement point for every centimetre of penetration) of the tip resistance, local sleeve friction and pore pressure.

With respect to the in-situ pore pressure measurement, the location of the porous stone is not standardised, but a position on the cone shoulder immediately behind the tip shall be preferred, in accordance with the recommendations of the ISSMGE. Continuous measurement of the pore pressure shall be made during penetration into the soil, or while penetration is interrupted for a dissipation test.

The test cones shall be checked in the laboratory at regular intervals for signs of wear of the cone tip and friction sleeve, the general electronics, and the sensitivity of sensors (accuracy and resolution of measurements). Calibration sheets shall be available with the test cones and shall be supplied at the COMPANY's Representative on board the vessel.

For any additional checks on the sensitivity of the sensors required before, during and/or after the offshore survey operations, the checking procedure used (i.e. test up to maximum sensor capacity or otherwise, test with or without umbilical, test with cone in sea water or not, test with different ambient temperatures, etc.) shall be supplied by the CONTRACTOR for approval.

6.1.1 Standard seabed surface CPTU test

For seabed surface cone penetration tests using independent equipment lowered onto the seabed, the CONTRACTOR's technical documentation shall include:

- Main dimensions and weight, type of handling equipment (i.e. derrick, crane, A-frame, winch, or other), as well as the instrumentation that is required to record the position of the frame on the seabed (for deep water sites)
- Maximum loading capacity and type of loading used to provide the penetration and reaction force (i.e. dead weight, suction force, or other), maximum possible length of penetration (depending on expected soil conditions)
- Main characteristics of the test cones, including: cone geometry, capacity and sensitivity of sensors
- System used to transmit measurements between test cone and surface (i.e. by electrical umbilical, acoustic transmission, or other)
- Availability of an inclinometer for monitoring the vertical alignment of the penetrometer rods embedded into the soil
- List of previous jobs performed with the proposed equipment, including: maximum water depth, maximum depth of penetration into the soil, and average operating times (depending on water depth and soil conditions).

When a seabed frame is used with this surface CPTU testing equipment, and in case of possible soft soils on the seabed, a stability assessment shall be supplied by the CONTRACTOR.

6.1.2 Standard deep bottom-hole CPTU test

For the deep bottom-hole cone penetration tests performed by means of wire-line tools operated through the drill string, the CONTRACTOR's technical documentation shall include:

- Main dimensions of the tool (length, external diameter), and type of drill pipes required to operate it
- Maximum loading capacity, type of loading device used to provide the penetration and reaction force (i.e. dead weight of drill collars and seabed frame, or other), and maximum possible length of penetration into the soil (depending on expected soil conditions)
- Main characteristics of the test cones, including: cone geometry, capacity and sensitivity of sensors
- System used to transmit measurements between test cone and surface (i.e. by electrical umbilical, acoustic transmission, or other)
- List of previous jobs performed with the proposed equipment, including: maximum water depth and maximum depth of penetration into the soil, and average operating times (depending on water depth and soil conditions).

6.1.3 Other types of cone penetration test

As indicated in the Particular Technical Specifications, and depending on the expected soil conditions and objectives of the geotechnical survey mentioned by the COMPANY, cone types that are different from the ISSMGE's reference cone (i.e. 36.5 mm diameter, 10 cm² cross-sectional area) shall be required, in particular:

- Cone with a cross-sectional area of 15 cm² (44 mm diameter) or more for very soft clays
- Cone with a cross-sectional area ranging between 1 and 5 cm² (11 to 25 mm diameter) for very dense sands, or for light-weight equipment applicable to shallow surface soil surveys.

For such tests, the CONTRACTOR's technical documentation shall include the detailed characteristics of the penetrometer cones, as well as the results of calibration tests showing the correlation, and any necessary corrections, with the results obtained with the ISSMGE's reference test cone.

Depending on the objectives of the geotechnical survey mentioned in the Particular Technical Specifications, the use of special test cones for in-situ measurement of additional parameters shall be required, including:

- Temperature and thermal conductivity
- Electrical conductivity and resistivity
- Soil density
- S and/or P wave velocity (seismic cone)
- Determination of pollution from hydrocarbons, or other.

For such equipment, the CONTRACTOR's technical documentation shall include the detailed characteristics of the test cones and operating procedure. The list of previous jobs performed with the proposed equipment shall also be supplied, including: examples of results obtained, maximum water depth, maximum penetration depth into the soil, and average operating times (depending on water depth and soil conditions).

6.2 Other in-situ tests

As indicated in the Particular Technical Specifications, and depending on the expected soil conditions and objectives of the geotechnical survey mentioned by the COMPANY, other types of in-situ tests shall be required, in particular:

- Standard penetration test (SPT)
- Vane test
- Dilatometer test
- T-bar penetration test
- Pressure meter test
- Hydraulic fracture test
- Gas sampling test
- Soil resistivity measurement test
- Geophysical borehole logging, or other.

For any types of test proposed by the CONTRACTOR, the technical documentation shall include:

- Main dimensions and characteristics of the test probe
- Operating procedure and reference test procedure (if no reference test procedure exists, a detailed procedure shall be supplied by the CONTRACTOR)
- Maximum capacity of the in-situ test sensors, and procedure for calibrating and checking the accuracy of measurements
- System used to transmit measurements between test probe and surface (i.e. by electrical umbilical, acoustic transmission, or other)
- List of previous jobs performed with the proposed equipment, including: examples of results obtained, maximum water depth, maximum penetration depth into the soil, and average operating times (depending on water depth and soil conditions).

6.3 Presentation of results

The various parameters measured in-situ shall be checked in real time, and simultaneously recorded on a digital medium. The parameters measured shall be presented before (gross measurements) and after (net measurements) any corrections, and the correction procedure applied shall be documented by the CONTRACTOR.

At COMPANY's request, and as mentioned in the Particular Technical Specifications, the in-situ test results shall be supplied on an IBM PC-compatible medium (i.e. 3.5" diskette and/or CD-Rom).

7. Laboratory test equipment and procedures

This section, dealing with the conditions applicable to the laboratory test operations to be carried out on the soil samples, concerns both the laboratory tests performed onboard the survey vessel during field operations, and the laboratory tests to be carried out onshore.

7.1 Laboratory tests performed onboard the survey vessel

The geotechnical drilling vessel shall be equipped with a laboratory, in which tests shall be performed in accordance with international standards and procedures (i.e. ISO, ASTM, BSI, NS, AFNOR, ISRM, or equivalent).

The laboratory equipment available onboard the survey vessel shall be in accordance with the Particular Technical Specifications. As a minimum, it shall include the equipment required for:

- Identification and visual description of the samples taken, with recovery (TCR, RQD and SCR for rock samples), geological description, colour (referenced to a standard colour chart), odour, structure, and consistency
- Measurement of water content, and wet and dry volume weights
- Measurement of undrained shear strength of clays by miniature torvane, pocket penetrometer, motorised laboratory vane, or by correlation with the fall cone test
- Unconsolidated undrained triaxial testing (UU tests) for clays
- Unconfined compressive testing, or point load index testing, for cemented soils and rocks
- Colour photographs of representative samples (with size and reference colour scales).

As indicated in the Particular Technical Specifications, and depending on the expected soil conditions and objectives of the geotechnical survey mentioned by the COMPANY, other types of laboratory tests shall be required. The performance of logs on samples (e.g. geophysical logs, logs to determine soil density, or other) may also be considered.

The work onboard shall be carried out by experienced personnel and supervised by a qualified geotechnical engineer. The laboratory test equipment shall be checked at regular intervals, and the calibration sheets shall be available with the corresponding equipment.

The laboratory test programme to be performed onboard the survey vessel shall be defined in co-operation between the CONTRACTOR's and the COMPANY's Representatives.

7.2 Laboratory tests performed onshore

7.2.1 Storage and transportation of samples

The CONTRACTOR is responsible for the safe transport of the samples to the approved onshore laboratory. In order to minimise any risk of disturbance, optimum conditions for the storage and conservation of soil samples shall be provided, both onboard the geotechnical survey vessel, and during transportation between the vessel and the onshore test laboratory (by sea, road or air), as well as at the onshore test laboratory itself.

The samples sent onshore for laboratory testing shall be fully identified, mentioning: survey site and project identifier, COMPANY's and CONTRACTOR's names, sampling date, geotechnical boring identifier and sample depth, as well as top and bottom of samples.

If soil or water samples are taken for geo-chemical or environmental analyses, the conservation procedures shall include the equipment needed to freeze the samples as they are received on the deck of the survey vessel until they reach the laboratory for analysis.

After completion of the onshore laboratory test programme, and unless otherwise stated in the Particular Technical Specifications, the CONTRACTOR shall store all of the remaining samples in a wet room for a period of at least one year after expiry of the Agreement. During such period, the CONTRACTOR is fully liable for any loss or damage to the samples. After this, the CONTRACTOR shall obtain written consent from the COMPANY before destroying the remaining samples.

7.2.2 Laboratory test programme

The onshore laboratory test programme, depending on the objectives of the soil survey mentioned in the Particular Technical Specifications and on the soil conditions encountered, shall be defined in co-operation between the CONTRACTOR's and the COMPANY's Representatives. The final test programme shall not start before approval of the proposed programme has been received from the COMPANY.

The onshore test laboratory shall be mentioned in the CONTRACTOR's technical documentation and shall allow for execution of tests in accordance with international standards (i.e. ISO, ASTM, BSI, NS, AFNOR, ISRM or equivalent). The tests shall be carried out by skilled personnel, supervised by a qualified geotechnical engineer.

If some of the proposed laboratory tests are not covered by a recognised standard and/or procedure, detailed technical documentation shall be provided by the CONTRACTOR, including a complete description of the test equipment and procedure, as well as examples of results obtained.

8. Evaluation and presentation of geotechnical parameters

This section concerns the evaluation of the results of the soil survey, and the definition of the geotechnical parameters for designing the foundations of the intended structure(s). The objective is to define references in order to ensure satisfactory and consistent quality of the geotechnical survey reports.

8.1 Soil conditions and geotechnical parameters

The soil conditions and geotechnical parameters shall be defined on the basis of all information available, including:

- Regional and local geological conditions
- Drilling logs
- Results of all in-situ tests
- Descriptions of all samples taken and results of all laboratory tests
- Correlations between in-situ and laboratory tests
- Results obtained from previous geophysical and/or geotechnical surveys at the site investigated or at neighbouring sites with similar soil conditions (if any).

The summary of this information shall enable:

- The different soil layers to be taken into account for geotechnical design purposes, and
- The geotechnical parameters required for physical and mechanical characterisation of each soil layer to be defined, as well as the parameters needed to design the foundations of the intended structure(s).

The bibliographical references used to justify the choice of correlations to determine geotechnical parameters on the basis of in-situ test results shall be supplied by the CONTRACTOR. Application of such correlations and/or in-situ test interpretation charts to the specific site soil conditions shall be checked against the data obtained locally during the geotechnical survey.

Whenever possible, and for each soil layer, an estimate of the uncertainty associated with the geotechnical parameters shall be supplied in the survey report, giving the mean value, standard deviation and coefficient of variation for each of the parameters considered. Any test results that may be affected by a degree of disturbance of the soil samples shall be clearly identified and shall not be included in the statistical calculations.

For a geotechnical soil survey including several borings distributed over the site surveyed, an estimate of the spatial variability of the soil characteristics in choosing the engineering parameters shall be provided.

8.2 Geotechnical and foundation engineering

The basic geometry of the foundations of the intended structure(s) are provided by the COMPANY in the Particular Technical Specifications.

Unless otherwise stated in the Particular Technical Specifications, the geotechnical and foundation engineering shall be carried out in accordance with the recommendations of the American Petroleum Institute, in particular:

- **API RP 2A** for the design of piled foundations and mud-mats for fixed steel structures (jackets)
- **API RP 2T** for the design of piled foundations for tension leg platforms (TLP)
- **API RP 2FP1** and **RP 2SK** for the design of moorings for floating structures
- **API RP 2N** for the design of subsea pipelines in arctic conditions.

For foundation concepts which are not covered by the API documents listed above, the documentation and bibliographic references justifying the choice of the engineering method considered shall be supplied by the CONTRACTOR for obtaining approval from the COMPANY. The approved design method shall be documented in detail in the final geotechnical survey report.

8.3 Database

The COMPANY may require the results of the soil survey to be transferred to an electronic database. The database format, provided by the COMPANY in the Particular Technical Specifications, shall be compatible with the recommendations of the Petroleum Open Software Corporation (POSC).

9. Reports to be submitted by the CONTRACTOR

9.1 Field report

The field report shall include all data obtained during the geotechnical survey works:

- Positions of geotechnical borings, with geographical and grid co-ordinates and the reference system (geodesy, datum shift, etc.), as well as the results of the positioning checks
- Water depth, as measured continuously during the survey works
- Brief description of the survey equipment and methods used
- Drilling logs, with drilling parameters recorded
- All results of laboratory tests performed onboard
- All results of in-situ tests
- Geotechnical boring logs, with description of the different soil layers identified
- List of samples packaged for transportation to the onshore test laboratory, with the laboratory test programme approved by the COMPANY's Representative
- Results of calibration and verification tests on the penetrometer cones and/or other in-situ test probes
- Complete daily activity reports.

Unless otherwise stated in the Particular Technical Specifications, the field report shall be submitted within one (1) week of completion of the geotechnical survey works in five (5) copies. The positioning report may be supplied in a separate volume.

9.2 Final geotechnical survey report

The final geotechnical survey report shall be in two separate volumes, one factual report containing a summary of the soil conditions, and a second volume for the engineering report containing the design studies for the foundations of the intended structure(s).

Unless otherwise stated in the Particular Technical Specifications, the final geotechnical survey report shall include:

9.2.1 Factual report

- Positions of the geotechnical borings, with a location map, geographical and grid co-ordinates with the reference system (geodesy, datum shift, etc.)
- Water depth, as measured continuously during the survey works (with type of equipment used and estimate of measurements accuracy), and average water depth referenced to LAT
- Full description of the survey equipment and methods used
- Description of the regional and local geological conditions
- Final results of all laboratory tests performed both onboard the survey vessel and onshore, including photographs of representative soil samples (with size and colour scales)
- Final results of all in-situ tests
- All final geotechnical boring logs, with description of the different soil layers identified and the geotechnical parameters for each formation
- Comparison of the soil conditions encountered against results obtained at the same site from earlier geophysical and/or geotechnical surveys (if any)
- Foundation engineering parameter
- Log of daily activities.

9.2.2 Engineering report

- Location map, with geographical and grid co-ordinates of the geotechnical borings
- Average water depth at the site (referenced to LAT)
- Geological interpretation of the lithology
- Geotechnical boring logs, with a description of the different soil layers identified and the geotechnical parameters for each formation
- Comparison of the soil conditions encountered against results obtained from earlier geophysical and/or geotechnical surveys at the same site or at neighbouring sites (if any), highlighting possible local features and differences or spatial variations revealed by the survey results
- Foundation engineering parameters
- Type of structure concerned and basic geometry of its foundation components

- Results of the foundation engineering studies, in accordance with the conditions given in the Particular Technical Specifications:
 - Analysis of possible risks related to the soil and environmental conditions, such as liquefaction, sliding, scouring and earthquakes
- Conclusions and recommendations concerning the potential problems likely to be encountered when installing the foundations of the intended structure(s).

Unless otherwise stated in the Particular Technical Specifications, a draft version of the final geotechnical survey report shall be submitted no later than six (6) weeks after completion of the survey works. No later than one (1) week after receiving the COMPANY's comments on the draft report, the geotechnical survey report shall be provided by CONTRACTOR in its final form, in ten (10) copies, including one unbound copy for reproduction purposes.

At COMPANY's request, and as mentioned in the Particular Technical Specifications, the final survey report shall also be supplied on a CD-Rom.

10. Quality assurance and safety procedures

10.1 Quality assurance

The technical documentation to be supplied by the CONTRACTOR shall allow the quality of the geotechnical services to be assessed. The Curriculum Vitae of all key personnel involved in the survey works shall be supplied by the CONTRACTOR, with a functional organisation chart.

The CONTRACTOR shall establish a quality control procedure for each phase of the geotechnical survey works. This procedure, which shall comply with the [ISO 9001](#) quality system or equivalent, shall be provided to the COMPANY's Representative onboard the survey vessel.

A survey work kick-off meeting shall be organised together by the COMPANY's and the CONTRACTOR's Representatives before the departure of the survey vessel from the port of mobilisation. In addition to the COMPANY's and CONTRACTOR's Representatives, this meeting shall be attended by the vessel's Master, the SUB-CONTRACTORS, and by any other parties involved in the survey works (e.g. offshore field manager and marine logistics, if required). The purpose of this meeting shall be to review the programme of works to be carried out, and to identify the other activities involved in the geotechnical survey, at or off the site. Minutes of the meeting shall be drawn up and signed by both the COMPANY's and the CONTRACTOR's Representatives.

During the survey works, the CONTRACTOR shall provide detailed daily progress reports. These progress reports, signed by both the COMPANY's and CONTRACTOR's Representatives, shall include a summary of the working hours and the chronology of the different survey activities. Any disagreement that can not be settled on the spot shall be noted and clearly documented in the daily report, so that later assessment is facilitated.

10.2 Safety and the CONTRACTOR's responsibility

All activities at sea and all questions concerning the safety of the survey vessel at sea, its crew and all personnel onboard the vessel during the field works, shall be the responsibility of the vessel's Master.

The vessel and the working procedures at sea shall comply with international regulations, in particular:

- IMO Conventions for the safety of life at sea (**SOLAS 74/78/81/83**)
- Classification and certification rules.

Master and crew shall demonstrate by performing (and recording) drills and exercises, that satisfactory emergency response capability exists onboard the survey vessel. Before the vessel leaves the port of mobilisation, a safety and evacuation exercise shall be carried out with all personnel involved in the geotechnical survey works.

The responsibility of the vessel's Master extends to ensuring that the CONTRACTOR and any SUB-CONTRACTORS are informed of and have access to the safety procedures for the different equipment onboard the survey vessel.

The CONTRACTOR's safety procedures shall be included in an overall safety plan. The COMPANY's general safety instructions will be handed to the CONTRACTOR who shall read them critically and point out any incompatibility there may be with his own safety system.

Heavy lifting equipment (i.e. cranes and heavy lifting winches) shall be certified. All certificates shall be available onboard the survey vessel and shall be provided at COMPANY's request.

In adverse weather conditions, it shall be required to cease operations when it may effect:

- The safety of personnel and of the vessel, in which case such adverse conditions shall be defined by the vessel's Master
- Or the quality of the geotechnical survey works, in which case such adverse conditions shall be defined by both the COMPANY's and the CONTRACTOR's Representatives onboard the vessel.

10.3 Inspection and acceptance of the survey vessel

In the event that the geotechnical drilling vessel proposed by the CONTRACTOR is not known by the COMPANY, or when the vessel has not been in use for more than one year, an acceptance visit or a thorough audit of the vessel shall be required (to be in agreement with **GS GEO 110**), including:

- General condition of the vessel (hull and superstructure, accommodations, common areas, etc.)
- Review of all vessel's certificates, including: class, registration, power, insurance, load lines, safety/life saving, management, maintenance and last dry dock certificates,
- Verification of the serviceability of the means of communication with land (VHF and BLU radio, satellite telephone and fax, etc.) and all onboard communication systems
- Onboard safety and evacuation equipment and procedures (life boats, life rafts, fire extinguishers and other fire fighting equipment, life jackets, hospital and first aid facilities, etc.)
- Verification of the serviceability of the mooring and/or DP system equipment and procedures
- Verification of the serviceability of the drilling equipment and procedures.