طرح نگهداشت و افزایش تولید 27 مخزن

SPECIFICATION FOR GEOLOGICAL & GEOTECHNICAL SURVEY

نگهداشت و افزایش تولید میدان نفتی بینک

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1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – General Facilities
EPD/EPC CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of : Hirgan Energy – Design & Inspection(D&I) Companies
VENDOR:	The firm or person who will fabricate the equipment or material.
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

2.0 SCOPE

This document covers minimum necessary requirements for carry out geotechnical surveys of the required areas and prepare detailed drawings, sketches and reports as required.

The work shall conform to relevant National Iranian and international standards and codes of practice, as well as to Contractor's reference documents, which includes the present

specification.

A Soil Resistivity and Crossings Survey is included in the scope of the present geotechnical survey.

The Geotechnical Survey will mostly consist in CPTu testing, recovery of disturbed and undisturbed soil samples, installation of ground water monitoring wells, trial pits or trial trenches, soil description, laboratory testing, conditioning, storage and reporting.

3.0 NORMATIVE REFERENCES

LOCAL CODES AND STANDARDS

- IPS-E-CE-110 Engineering Standard for Soil Engineering
- IPS-E-CE-120 Engineering Standard for Foundations
- IPS-E-CE-130 Engineering Standard for Piles
- IPS-E-CE-140 Engineering Standard for Retaining Walls
- IPS-C-TP-820 Appendix B - Measurement of Soil Resistivity
- ISDCOI-038 Iranian Seismic Design Code for Petroleum Facilities & Structures (3rd Edition)
- STD-2800 Iranian Code of Practice for Seismic Resistant Design of Building (4rd Edition)

INTERNATIONAL CODES AND STANDARDS

- ASTM C227 Standard Test Method for Poential Alkali Reactivity of Cement – Aggregate Combinations
- ASTM C289 Standard Test Method for Poential Alkali-Silica Reactivity of Aggregates
- ASTM C977 Standard Specification for Quicklime and Hydrated Lime for Soil Stabilization
- ASTM C998 Standard Practice For Sampling Surface Soil For Radionuclides
- ASTM D1140 tandard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
- ASTM D1143 Standard Test Method for Piles Under Static Axial Compressive Load
- ASTM D1194 Standard Test Method for Bearing Capacity of Soil for Static Load & Spread Footings
- ASTM D1195 Standard Test Method for Repetitive Static Plate Load Test of

Soils & Flexible Pavement Components

- ASTM D1196 Standard Test Method for Non-repetitive Static Plate Load Test
- ASTM D1241 Standard Specification for Materials for Soil-Aggregate Sub-base, Base, and Surface Courses
- ASTM D1452 Standard Practice for Soil Exploration and Sampling by Auger Borings
- ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
- ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
- ASTM D1558 Standard Test Method for Moisture Content Penetration Resistance Relationships of Fine
- ASTM D1586 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils
- ASTM D1883 Standard Test Method for California Bearing Ratio
- ASTM D2166 Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
- ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
- ASTM D2487 Classification of Soils for Engineering Purposes
- ASTM D420 Standard Guide for Site Characterization for Engineering Design and Construction Purposes
- ASTM D3385 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer
- ASTM D3441 Standard Test Method for Mechanical Cone Penetration Testing of Soils
- ASTM D3550 Standard Practice For Thick Wall, Ring-Lined, Split Barrel, Drive Sampling Of Soils
- ASTM D3148 Standard Test Method for Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression
- ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods
- ASTM D4219 Standard Test Method for Unconfined Compressive Strength Index of Chemical- Grouted Soils
- ASTM D5334 Standard Test Method for Determination of Thermal Conductivity of Soil and Rock by Thermal Needle Probe Procedure
- ASTM D5195 Standard Test Method for Density of Soil and Rock In-Place at Depths Below Surface by Nuclear Methods

- ASTM G51 Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing
- ASTM D57 Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four Electrode Method
- BS 5930 Code of Practice for Site Investigatons
- BS 7755 Soil Quality
- BS 1377 Soil for Civil Engineering Purposes
- BS 6031 Code of Practice for Earthworks
- BS 8004 Code of Practice for Foundations

THE PROJECT DOCUMENTS

- BK-GNRAL-PEDCO-000-CV-SP-0002 Specification for Road & Paving
- BK-GNRAL-PEDCO-000-CV-SP-0004 Specification for Earth Work

ENVIRONMENTAL DATA

Refer to "Process Basis of Design; Doc. No.BK-GNRAL-PEDCO-000-PR-DB-0001".

ORDER OF PRECEDENCE

In case of any conflict between the contents of this document or any discrepancy between this document and other project documents or reference standards, this issue must be reported to the CLIENT. The final decision in this situation will be made by CLIENT.

4.0 GEOLOGICAL & FAULT ASSESSMENT SURVEY

GENERAL INFORMATION

Preliminary to the Geotechnical Survey, the Geological & Fault Assessment Survey is required as described in the present document.

The purpose of the Geological and Fault Assessment Survey is as follows:

GEOTECHNICAL CONCERNS

One of the objectives of the Geological and Fault Assessment Survey is to address the geotechnical concerns it shall specifically aim at:

- establishing local and general Geology of the site,
- preparing, supporting, optimizing the Geotechnical Survey, and to help interpreting, and assessing continuity of, the geotechnical data,
- Localizing and assessing borrow areas for fill material.

SEISMICITY CONCERNS

Besides, the survey shall aim at addressing seismicity concerns, and more specifically:

- identify, locate, and assess the activity of faults
- Collect information relevant for the assessment of the general and local Seismicity.
- Collecting special information about the compressor unit.

BORROW AREAS

Fill material will be required during the construction phase of the plant areas and roads, mainly for the following purposes:

- Over-site fill to raise the ground level of each site for flood protection;
- Bunding around storage tanks;
- Engineering fill for road construction.

addition to local cohesive material from above the ground water table, granular materials, in the form of dug gravel or crushed rock, will be required for road works, pavement construction and, potentially, for backfill in areas of soft formation and protection of embankment side slope.

The geological survey shall aim at localizing and assessing potential borrow areas and/or quarries for this fill material.

4.1.1 PHASES OF THE SURVEY

The Geological & Fault Assessment survey will be performed by one senior Geologist and one senior Seismicity Expert, by the means of:

- desk studies,
- site walk-over,
- Trial Pits or Trenches,
- Boreholes and additional pits or trenches that will be performed during the Geotechnical

Survey as per the recommendations of the Geologist and Seismicity Expert in their final report.

The Geological & Fault Assessment Survey shall be divided in four phases:

- Phase 1: desk study,

- Phase 2: on site Geological & Fault Assessment Survey including geological visit and trenching,
- Phase 3: geo-hazards, landslides, faults and proposed locations of geotechnical testing, and reporting,
- Phase 4: additional boreholes and Trial Pits or Trenches shall be recommended in the final report to corroborate its conclusions. Optionally, a review of the final report may be requested in the light of the outcome of phase 4.

4.1.2 GEOTECHNICAL SURVEY

Subsequently to the Geological & Fault Assessment Survey, a geotechnical survey over the pipe route is being organized primarily to:

- assess hydro-geological conditions
- identify and localize the geo-hazards areas (swamp areas, liquefaction, landslides, river-crossings, faults crossings);
- gather the geotechnical data required stability analysis and definition of appropriate mitigation measures;
- Assess excavatability of soil, and specifically localize and characterize any rock formation.

In addition, the geotechnical survey will aim at:

1- Ruling out concerns of possible soil instability: sand liquefaction, soil collapsibility, swelling and shrinking grounds, soil consolidation, soil bearing capacity;
2- Assessing water table level and risks of trench inundation;
3- Assessing chemical properties of soils and groundwater;
4- Characterizing natural backfill material;
5- Providing additional information for faults and seismic hazard assessments;
6- Providing information for landslide assessment;
7- Providing information for evaluation of pipeline stability and settlement in swamp (soft soils) areas;
8- Providing adequate and reliable laboratory and in-situ testing to evaluate the geomechanical parameters, to assess the engineering problems and to define the appropriate construction measures and necessary reinforcements for the short and long term stability.

PROPOSED SENIOR GEOLOGIST & SEISMICITY EXPERT

Construction contractor shall source a senior Geologist and a senior Seismicity Expert of international renown of at least 15 years of experience, experienced in the Iranian context and in

Oil & Gas projects. The Senior Geologist and the Seismicity Expert are subject to approval by EPCM CONTRACTOR. Detailed cvs and lists of correlating projects successfully completed by the proposed experts shall be submitted to the EPCM Contractor's scrutiny, which reserves the right to assess the expertise of the proposed experts through an interview.

The whole Geological & Fault Assessment Survey as described in the present document shall be performed under the sole technical responsibility of the Senior Geologist and of the Seismicity Expert.

In order to ensure this Geological & Fault Assessment Survey is efficiently performed with a clear benefit to the PROJECT, it should be performed in close cooperation with EPCM Contractor's geotechnical engineers, which will ensure it targets the specific concerns and interests of the PROJECT.

DESK STUDY

In order to prepare as thoroughly as possible the subsequent phases of the geotechnical and of the Geological & Fault Assessment surveys, a preliminary desk study shall be conducted.

This work shall consist in collecting as much information as possible, including:

- topographical maps
- geological maps
- remote sensing documents such as satellite pictures, stereoscopic aerial photographs,
- maps and studies previously established for other purposes, such as water resources,

geological and agricultural purposes, very often published or made available by governmental or private institutes.

This information is highly valuable and shall be gathered with active assistance from all concerned parties in order to be as exhaustive as possible.

Specifically, the desk study shall also focus on fault related features, and produce a preliminary Quaternary geology and geomorphology map of the site.

The accuracy and pertinence of this preliminary study will greatly impact the quality of the following steps of the definition of the geological context.

PHASE 2: SITE SURVEY

4.4.1 VISIBLE FEATURES

A geological visit areas shall be conducted by the Geologist and by the Seismicity Expert.

The Geological & Fault Assessment Survey aims at:

- assessing the general geological context of the area;
- assessing the local geology, rock or soil type, layer geometry, thickness;
- assessing the main geological boundaries and fault delineation, including based on the remote sensing and desk study;
- detect all neo tectonics evidence, slope instability, indications of fault movements;
- identify and locate all geological or fault related features;
- Localize and assess potential borrow areas and/or quarries for fill material.

The Geologist and Seismicity expert shall survey selected areas based on the desk study. This supposes that all points of the pipe route can be reasonably, easily and safely accessed.

Besides the mapping, a classification of the mass movements shall be performed.

All the major geo-morphological features typical of landslides shall be described together with the hydraulic data including the groundwater sources and the typical associated vegetation.

PHASE 3: SYNTHESIS & REPORTING

An extensive report shall be established with the following purpose:

- summarize the geological main contexts highlighting each specificity impacting on the pipe design, in simple words, in view of the explicit objectives of the Geological & Fault Assessment Survey,
- discuss on pipe route context with a specific interest for geo-hazards such as landslides and faults,
- propose alternative routes when deemed necessary,
- help defining and locating the geotechnical and geophysical testing and sampling
- program,
- Provide an evaluation of the various potential sources for backfill material (nature / type, geological description and estimated volume).

The report shall include 3D imaging of the outcome of the Geological & Fault Assessment Survey with professional geological imaging softwareProfiles shall be delivered in standards Dwg or Dxf format in local (PROJECT) coordinates ready to be incorporated in AutoCAD drawings. The format standards will be provided by the EPCM Contractor.

Geological Reports on one hand and Faults & Seismicity Assessment Reports on the other hand, may be either separated or integrated, as deemed appropriate by the respective experts and as discussed with the EPCM Contractor's Representative.

PHASE 4: UPDATE OF THE REPORT

The synthesis may be needed to be updated with the outcome of the geotechnical survey once it is completed, for a comprehensive integrated review of the soil conditions. This phase is optional, and may be requested by the EPCM CONTRACTOR.

5.0 GEOLOGICAL WALK-OVER

Acting as a professional geotechnical consultant during the performance of the Work, contractor shall carefully note and report any information on site that may be of any interest for the project in general and in particular for the assessment of the soil and water table conditions.

Specifically, contractor shall perform a geotechnical walk-over in view of the preparation of the Geotechnical Survey.

The geotechnical walk-over differs from the Geological Survey; it shall be organized as follows:

- include description of indications of water, man made features, buildings, constructions, indications on the vegetation if relevant, etc …
- The transportation mean shall be primarily by foot. If the soil conditions are very uniform, the transportation mean may be a motorcycle, safety requirements allowing. The use of a car for the survey itself should be limited to clearly defined sections identified as very homogeneous, and would request explicit agreement from the EPCM Contractor's representative
- Assess site accessibility for drilling rigs or other vehicles, including ambulances.
- Safety conditions allowing, the geotechnical walk-over survey shall be performed before soil testing or sampling.

6.0 GEOLOGICAL OPERATIONS

GENERAL

6.1.1 COORDINATION & CONTROL

All survey works shall be performed under the responsibility of skilled and experienced geotechnical engineers. Construction contractor shall ensure that adequate and reliable geotechnical data are provided. This is especially valid in establishing the survey concept, testing and sampling methodologies, choosing of appropriate

equipment, the coordination and quality control of the survey work and safety and health.

The Contractor's Site Manager shall have at least 15 years practical experience in similar projects.

EPCM CONTRACTOR and its representative will supervise the work and give instructions on the procedure of the work where deemed appropriate. This supervision does not relieve the Construction Contractor of his own responsibility for the execution of all surveying works.

Field and office works shall comply with the local standards requirements. Namely, raw data shall be submitted daily with the Daily Progress Report.

Field Reports shall be submitted Weekly for site work, laboratory testing and office work.

6.1.2 METHOD STATEMENT

Contractor shall familiarize himself with all Iranian regulations and laws covering the activities included in the survey works and shall obtain and submit to employer all the necessary authorizations and permits prior to starting the works.

Contractor shall submit to EPCM Contractor a detailed method statement clearly identifying all activities of the survey work to be performed prior to carrying out any survey activity.

Method statement shall reflect the data gathering and data processing philosophy of this specification and describe methodology and organization for the execution of the work.

Contractor shall specify a preliminary method statement including: Survey methods

Contractors organization

Within 10 days from the contract award, the Contractor shall submit the method statement (working procedure) including:

Detailed procedures for the performance of the survey, data processing and reporting, logistics, safety measures, emergency response, etc …

Contractors' organization

List of means of transport with identification data

List of instruments and equipment

List of software with specifications and name of the Editor.

List of specialized personnel to be employed for the work and the career profile of responsible positions (i.e. surveyors co-coordinator of activities)

List of the computer programs and the releases that Construction Contractor intends to utilize for the work.

Specifically, Contractor shall identify and detail all the tasks for which they don't have the capacity internally or readily available. Remediation for this lack shall be established with the EPCM Contractor.

6.1.3 INSTRUMENTS AND EQUIPMENT

To perform the work, Construction Contractor shall use modern geotechnical and geophysical instruments and equipment.

The survey equipment to be used for the work shall be operated by qualified persons experienced in the use of equipment.

The instruments and equipment shall have been recently calibrated and shall be subject to regular checks, during the survey period, to ensure accuracy. Calibration report shall be provided to EPCM CONTRACTOR before starting the survey work.

The survey instruments and equipment shall be suitable for prolonged use in the condition proper to BINAK area.

6.1.4 SURVEY EQUIPMENT – SETTING AND CERTIFICATES

Each measuring equipment shall be identified by a tag number punched in the identification plate. The calibration sheet of the measuring equipment shall be provided with the following information:

- Instrument tag number

- Date of the last setting/calibration carried out on the equipment iii) Expire date of the setting/calibration

Construction Contractor shall make available to EPCM Contractor the certificates or calibration report of each equipment before their utilization. Calibration Certificates shall be issued by an independent acknowledged entity. These certificates shall be part of final survey report.

6.1.5 PERMIT TO SURVEY AND SITE SECURITY REQUIREMENTS

Construction Contractor shall conduct the field work in accordance with Employer and Employer's representative site security procedures and directives, in full compliance with the specific UXO related requirements.

6.1.6 DAILY PROGRES REPORT(DPR)

During field works, a DPR shall be submitted daily 12 h after completion of the day of concern and shall include, but not be limited to the following information:

- Daily progress and work completed,
- Weather conditions,
- Mobilized resources and equipment, and cause of any interruptions,
- Equipment damage,
- HSE performance.

Before the beginning of the field work, Construction Contractor shall submit a DPR form for EPCM Contractor approval.

For Office or Laboratory work, Construction Contractor shall submit a weekly progress report.

6.1.7 DATA HAND-OVER

All data acquired during the work are the property of the Construction Contractor shall hand over to EPCM Contractor all data including raw data (in ASCII and proprietary format) and intermediate results, as well as all details of processing and interpretation methodologies, in electronic and hard copy as requested.

CPTU

The CPTu tool and operating procedures shall comply with the ASTM and with the industry standards, (as established for example in Cone Penetration Testing in Geotechnical Practice by T.LUNNE, P.ROBERTSON and J.POWEL).

Effective thrust capacity of the CPTu rig shall be of 10 tons minimum. The penetration rate shall be of 20 mm/sec as per standards. Penetration rate shall be electronically monitored. The CPTu

includes measurements of tip resistance, friction, excess pore pressure and tilt. Before the commencement of the operations and upon request at any time of the project, Construction Contractor shall demonstrate the thrust capacity of the CPTu equipment by a system that measures the total thrust actually transmitted to the CPTu rod. Centralizers shall be installed if necessary to prevent rod buckling. Ideally, an independent measure shall be performed. Alternatively, cone tip reading is acceptable if the calibration sheet of the cone is provided.

CONSTRUCTION CONTRACTOR shall take specific care to ensure the reliability of the pore pressure measurement, including with frequent and thorough saturation of pore pressure filters prior to testing.

The CPTu test must be performed down to the total depth of the predicted boreholes. For this purpose the penetration will be started by CPTu. After reaching to the refusal depth, all the instruments must be removed from the borehole. The borehole should be washed out and prepared for continuation of CPTu from the previous depth. From this depth with a special setup for preventing from rod buckling CPTu should be continued until the next step of refusal is reached. For this combination a special system which must have both capabilities of drilling and CPTu testing must be be mobilized at the same time. Before starting the test, the steps of drilling and CPTu testing after reaching to early refusal must be defined and agreed by the client and the contractor.

a) Cone saturating Procedure

At the end of daily work time, cones were disassembled, completely cleaned, lubricated (all of the o-rings) and re-assembled. The cones were then put in the de-aireator cell. In this unit, with the aid of a vacuum pump the air bubbles are removed and silicon oil is substituted. The pump continues working for at least 10 hours. After that the de-aired cones were covered with a plastic foil which was removed when the cone penetrated into the soil.

b) Depth measurement during CPT testing

During CPT, the depth of testing was measured by a depth encoder instrument. Depth encoder is an electronic device which was attached to the data logger and recorded the amount of penetration of the cone into the soil by measuring the length of a thread which was wrapped around a pulley.

FIELD REPORTING

The day following the performance of a test, an electronic copy of all raw data shall be delivered in proprietary together with all information necessary for the data processing, including:

- cone ID and calibration sheet

- baseline for all sensors before and after test at ground level
- clarification for any stop of cone penetration other than adding a rod
- date and time and location of test
- identification of operator
- a paper or electronic copy of a plot of non-corrected data (tip, friction, pore pressure) in engineering units

REFUSAL

Unless otherwise specified, every designated location shall be tested with the CPTu, continuously from ground level to target depth.

In case of refusal due to soil resistance, the thrust on the rod shall be increased to at least 7.5 tons. A refusal at a smaller thrust than 7.5 ton will be considered as equipment breakdown and the test will not be considered as completed. It is essential that any CPTu refusal is explained.

- If the refusal cannot be satisfactorily explained by soils conditions, the CPTu tool shall be examined for defects, and the test shall be repeated.
- If the refusal occurs above GSMD and is satisfactorily explained by soil conditions, a borehole of type A shall be performed at least to GSMD.
- If the refusal occurs below GSMD and is satisfactorily explained by soil conditions, the CPT test shall be deemed completed.

Upon request, Construction Contractor shall be capable of performing combined CPTu testing and drilling or coring as deep as 50 m. Upon request, Construction Contractor shall perform dissipation tests further to CPT tests.

CBR

Proctor and site Californian Bearing Tests (CBR) shall be performed at every CPTu location. The purpose of the CBR tests is to assess the stability of the machineries on site (excavators, cranes, side boomers, etc ...).

For Soil Collapsibility qualitative assessment, an additional CBR test may be requested by the EPCM Contractor after soaking the soil with water.

GROUND WATER MONITORING WELLS (GWMW)

Ground water level is of prime importance for the assessment of trench inundation risks during installation, for the evaluation of the pipeline stability (buoyancy control) in very soft soil or liquefiable sands, and for corrosion assessment over the lifetime of the pipeline.

As far as HSE allows, especially with respect to UXO (Unexploded Ordnance), GWMW shall be preferably located near the border of the corridor in order not to be damaged by the trench excavation process.

Specifically, or in addition to the ASTM:

- GWMW shall be preferably installed in a coring/sampling borehole.
- The well shall be installed such as to collect ground water from ground level down to halfa meter below target trench bottom level. If the well is installed in a borehole deeper than requested for the well, the lower part of the borehole shall be grouted. A typical mix might be 4 parts of bentonite mixed thoroughly with 8 parts to 12 parts of water to which is added one part of ordinary Portland cement. Grout shall be injected from the bottom of the hole.
- The top of the standpipe shall protrude about 0.5 m above ground level, and shall be encased above ground level into a steel pipe fitted with a threaded screw cap and a lock.
- A small concrete monument shall be built at ground level as a foundation and protection of the protruding steel casing. Approximate dimensions shall be 200 mm x 200 mm side, 300 mm in ground + 300 mm above the ground. The monument shall additionally protect the GWMW from surface waters.
- The protruding steel casing shall be painted with yellow and black stripes.
- GWMW shall be built so as to also enable water sampling for environmental or corrosion assessment purposes.
- Water level measurements will be performed on a weekly basis unless instructed otherwise.
- Where deemed appropriate (upon instruction of the EPCM Contractor's representative), Lefranc in-situ permeability tests shall be performed at selected locations.

FIELD WATER CONTENT AND UNIT WEIGHT MEASUREMENT

Soil or rock fragments shall be immediately selected and conditioned in airtight pre- weighted jars suitable for water content measurements as per ASTM, with adequate labelling.

Whenever possible (i.e. in soft cohesive soils), the soil fragments shall be sub- sampled for unit weight measurement with a stainless steel sub-sampler of known volume (also known as density ring).

Jars shall be all of the same type. Air tightness shall be demonstrated by weighting a random selection of 10 jars half filled with water before and after a 24h period in an oven at 60° Celsius.

Only samples taken with a dry method (e.g. single barrel coring, push sampling) or rock fragments (even if taken with water circulation) can be used for water content measurement.

TYPE A BOREHOLE (BH A)

Two types of boreholes shall be performed, type A and type B.

General the purpose of type a borehole is to collect samples specifically for

Laboratory testing, which requires

- no disturbance and no loss of moisture for cemented or cohesive soils
- no particles segregation for non cohesive soils

Type A boreholes shall primarily be performed with static push sampling.

Soil Samples shall be conditioned on site immediately upon recovery and logging. Conditioned samples shall be transferred the same day (e.g. at end of shift) to the site

storage place. From then on, the storage temperature shall be controlled and maintained between 5 ° and 35 ° Celsius at all times. This includes site storage place, transportation means (e.g. refrigerated truck), soil laboratory, and permanent storage place.

All samples shall be stored in a temperature controlled area at least one year following the completion of the WORK.

Shelby tubes shall be made of stainless steel, with an outside diameter of 76 mm minimum, and a length of 1 m. Several wall thicknesses can be used, but Construction Contractor shall make available a sufficient number of tubes of at least 2.5 mm thickness.

The Shelby tube thrust capability shall be of at least one ton. The capability of producing this thrust shall be demonstrated with a load cell upon request at any time of the WORK.

The penetration rate shall be of approximately 2 cm/s. Percussion methods are not acceptable.

Shelby tubes shall not be extruded on site.

The soil observed at the bottom of the tube shall be described as per ASTM, and tested with Pocket Penetrometer and Pocket Torevane. An adequate portion of soil shall be taken and placed in an air tight jar for water content measurement. If practicable, this portion shall be taken with a sub-sampler made out of a stainless steel tube of known volume for unit weight measurement.

The Shelby tube shall then be sealed in liquid wax at top and bottom. At top, a sufficient amount of wax shall be poured to cover the samples with at least 5 cm. At bottom, the Shelby tube shall be placed in a cardboard or PVC tube or equivalent, which shall be filled with wax such as to cover the Shelby tube and sample with at least 3 cm of wax at bottom and 1 cm on the side.

Extrusion shall be performed in the laboratory at time of test, with an appropriate equipment involving a piston driven at a controlled rate of 2 cm/s maximum.

Samples from type A boreholes, obtained with rotary coring techniques subsequently to push refusal, shall be extruded on site. Hammering the barrel, or pushing out the

sample with water back pressure will not be tolerated. Extrusion shall be performed by hand for split barrels, or by cutting the plastic liner for triple barrel. In addition to the requirements of paragraph 6.8 Type B borehole (BH B), the following shall be implemented:

Condition all collected soil, except cuttings.

SPT TESTING AND SAMPLING

SPT testing shall be performed where requested with a standard free-fall hammer with an automatic release system. Blow count shall be recorded as six steps of 75 mm of penetration each. Soil sample shall be described in detail as per ASTM, and adequately labelled and conditioned in two bags made of strong and thick watertight material. (See Attachment B)

SPT hammer shall be available on all rigs, and performed as instructed by the EPCM Contractor's representative.

A minimum of 100 blows shall be given for SPT tests failing to reach the full penetration of 300 mm (plus 150 mm seating drive).

TYPE B BOREHOLE (BH B)

The purpose of type B borehole is mostly soil identification, by visual description on site and by identification tests in Laboratory, which tolerates disturbance and loss of moisture.

In type a boreholes, soil sampling may proceed with rotary coring only upon refusal of push sampling with a thrust of at least one ton.

The core diameter shall be of 100 mm minimum. Below 15 m depth, the core diameter may be reduced to 86 mm.

- In cohesive or cemented soils, rotary coring shall be performed with triple barrel (or double barrel with an internal transparent PVC liner). Alternatively, double barrel coring with internal split barrel is acceptable.

Note: if triple barrel or split double barrel systems cannot be found in Iran, double barrel coring might be acceptable if extrusion is performed carefully with an extruder involving a piston of the barrel's diameter, pushed at a controlled rate of 2 cm/s maximum.

- In granular soils, rotary coring shall be performed with single barrel without any fluid circulation.

The maximum length of core runs shall be 1.5 m. In case of recovery of less than

80%, the core length shall be reduced successively to 1 m and 0.5 m. The core obtained by rotary coring shall be extruded on site.

In Rock, the following parameters shall be logged:

- Total Core Recovery (TCR).
- Rock Quality Designation (RQD).
- Solid Core Recovery (SCR).
- Fracture spacing.

SOIL DESCRIPTION

Soil description shall be performed as per ASTM on dedicated A4 soil description forms that shall not cover more than 1.5 m of soil depth, subject to EPCM Contractor's approval, before the commencement of the work.

Immediately upon extrusion, cores or samples shall be photographed with a digital camera in a resolution of at least 3 megapixel.

If hard object is hit during excavation at depth of less 3 meter , the contractor must perform drilling operation up to a depth of at least of 3 meters to determine the soil characteristics

HANDLING, TRANSPORTATION & STORAGE OF SOIL & ROCK SAMPLES

Samples collected from Type B boreholes shall be stored in core boxes. Cohesive and cemented soil may be stored directly in the wooden box.

In order to avoid particles transfer and segregation during transportation, granular soils shall be conditioned in large bags (equivalent to about 0.25 m of core). Soil showing any difference in nature, origin or properties shall not be mixed in the same bag.

Samples shall be displayed in the core box as per industry standard, e.g. with increasing depth from top to bottom and from left to right, with wooden separators to identify core runs. Depths shall be indicated on the bags and on the box.

All samples (including Shelby tubes) and core boxes shall be labelled with the following information as a minimum:

- EMPLOYER name,
- PROJECT name,
- CONSTRUCTION CONTRACTOR name,
- CONSTRUCTION CONTRACTOR project number,
- Date,
- Corridor branch, corridor number,
- Borehole number, type of borehole (A/B),
- Depths of top and bottom of sample,
- Top/bottom for wax samples.

CONSTRUCTION CONTRACTOR shall obtain a written authorization from EPCM CONTRACTOR before disposing of the samples, at least one year after completion of work.

TRIAL PITS OR TRENCHES

Trial Pits or Trenches shall be performed using a back-hoe excavator with the capability of digging to a depth of 4 m. Pits shall be maintained with a bottom surface of about 2 m x 1 m. By defaults, the trench length shall be of 10 m.

No personnel shall enter a pit or a trench deeper than 1.5 m. Upon completion of the pit or trench, it shall be filled again with its original material. If a trial pit or trench has to be left without active attendance, and at end of shift, the pit or trench shall be surrounded by reflective safety strip at about 1 m height.

The performance of the trial pit or trench mainly aims at confirming the geological trends and continuities observed in the boreholes and CPTu locations, taking soil samples for laboratory tests.

Additionally, Trial Pits or Trenches aim at confirming excavatability of the soil and checking ground water level. Any difficulty encountered during excavation shall be carefully recorded. Whenever practicable the material where excavatability is difficult shall be specifically sampled.

Geological trial trenches shall be performed for the purpose of landslides and/or fault assessment, at locations specified by the EPCM Contractor and Geotechnical Consultant.

The trial pit or trench shall be performed and a soil log shall be established as per ASTM.

Samples for water content and unit weight measurement with watertight jars shall be taken as far as representative of the soil. Colour Digital Photos of samples and of the pit or trench wall down to 1.5 m depth shall be taken with a standard colour chart.

The Contractor shall organize for:

- disturbed samples for:

  a) Moisture content in airtight jars b) in-situ density in airtight jars
  b) Bags for Proctor d) Bags for lab CBR
  c) Bags for grain size analysis or Atterberg limits

- undisturbed samples in cohesive soils for:

  a) triaxial tests
  b) oedometer tests

The final depth of the trial pits or trenches shall be as requested by the EPCM Contractor, and by default of 4 m.

SOIL RESISTIVITY AND CROSSINGS SURVEY

Soil resistivity shall be performed over the whole plant Specification for soil resistivity and crossings survey.

HSE measures shall be prepared thoroughly

FIELD REPORTING

Any site work is considered completed only when the related Field Report has been submitted. Field Report includes type of test, site coordinates, time of performance, implemented standards, raw data including calibration sheets. Legible hand written documents in English language are acceptable. Construction Contractor shall deliver the raw data and factual information to the EPCM Contractor within 24 hours after acquisition.

A form for the Field Reporting for every site work shall be submitted to EPCM CONTRACTOR for approval fifteen days before the commencement of the work. Field data shall be submitted 24 h after completion of the work, and put together in a monthly field report every month.

7.0 GUIDELINES FOR SAMPLING & TESTING PROGRAMME

The scope of work shall be established by the EPCM Contractor at time of operations, integrating available geological information. The scope of work will include the target depths of borehole or testing locations.

8.0 LABORATORY TESTING

GENERAL

No laboratory is requested on site, only soil visual description and sample conditioning shall be performed on site. All Laboratory testing shall be performed in Construction Contractor's premises.

Tests shall be performed primarily as per ASTM standards. The following sequence shall be applied:

- all calibration sheets are submitted
- laboratory is inspected by EPCM Contractor
- Laboratory testing Order Sheets are proposed by Construction Contractor
- Laboratory testing Order Sheets are commented and amended
- Testing might only commence upon reception of Laboratory Testing Order Sheets

approved and duly signed by EPCM Contractor

SOFTWARE FOR DATA PROCESSING

CONTRACTOR shall use standard forms and software available on the market and not in-house software or spreadsheets for laboratory data processing and reporting. The proposed software and forms shall be detailed. It shall allow for export in AGS format. All laboratory results shall be provided also in electronic AGS format.(Association of Geotechnical Specialists)

TYPES OF TESTS

Contractor shall make provision for the following tests to be performed:

8.3.1 CLASSIFICATION AND IDENTIFICATION TESTS: VISUAL CLASSIFICATION

Detailed structural description

Moisture content

Plastic and liquid limits on cohesive soils – specifically, Atterberg limits may be requested on the fines only or on the whole material. Clays and Silts shall be distinguished based on Atterberg limits,

Total and submerged unit weight

Specific gravity

Microscopic examination for petrographic analysis of rock

8.3.2 PARTICLE SIZE DISTRIBUTION

Wet sieving through 63/75 micron sieve, with maximum particle size 20mm

Wet sieving through 63/75 micron sieve, for particular sizes greater than 20mm per

10kg of material

Percent passing single sieve

Dry sieve analysis of coarse grained soil

Hydrometer analysis of fine grained soil

8.3.3 DENSITY & BEARING CAPACITY

Minimum and maximum density of coarse grained soil

Standard Proctor test Modified Compaction test CBR test

8.3.4 PERMEABILITY TEST

8.3.5 ORGANIC CONTENT

Organic content by loss on ignition

Volumetric analysis

8.3.6 CHEMICAL TEST

Determination of total carbonate content

Determination of salts content

Determination of total acid soluble sulphate content of soil

Determination of water soluble sulphate content of soil containing over 0.5% acid soluble sulphates

Determination of pH of soil or groundwater

Determination of the chloride content on soil, rock or groundwater sample

8.3.7 MECHANICAL TEST

8.3.8 STRENGTH TEST

Motorized laboratory vane

Miniature vane

Point load test

8.3.9 TRIAXIAL COMPRESSION

Uniaxial unconfined compression (UCS) test on rock with Young's Modulus measurement

Unconsolidated undrained (UU) triaxial test in clay

Consolidated undrained (CU+U) triaxial test on clay, including pore pressure measurements

Consolidated drained (CD) triaxial test on sand

Consolidated drained (CD) triaxial test on silt or clay

8.3.10 COMPRESSIBILITY

Consolidation test on cohesive soil, including secondary compression, with 7 or less loading stages to maximum pressure of 800kPa,

Consolidation test on sand, up to maximum pressure of 800kPa with determination of

Cpl index,

Collapsibility tests. The purpose of soil collapsibity tests is primarily to assess the accessibility and stability of the machinery to the site (excavators, side boomers, cranes, etc …).

8.3.11 MESCELLANEOUS

Photograph of soil sample or rock core.

LABORATORY SCHEDULE PHILOSOPHY

Construction Contractor shall prepare Laboratory Testing Order Sheets on the basis of the following principles. Based on the outcome of the ongoing survey, EPCM Contractor might modify the following principles and significantly alter the Laboratory Testing Order Sheets as proposed by the Construction Contractor.

8.4.1 GENERAL

As a basis, only soils from above GSMD shall be tested. In some specific cases (e.g. swamps or loose soils, landslide areas) soils may need to be characterized at greater depths.

The following tests shall be requested as many as every 0.5 m of depth.

If soil is suspected of being collapsible, propose collapsibility tests

Note: Soil collapsibility raises serious concerns about the accessibility and stability of the machines used to excavate the trench or install the pipeline.

If soil is very soft, propose oedometer tests below trench bottom, and strength tests, identification tests and triaxial tests above trench bottom.

Perform carbonate content and chemical tests as requested Contractor

8.4.2 COHESIVE SOILS

1- Assess primarily undrained shear strength Su of cohesive soils with per meter of sample
2- Perform moisture content and unit weights tests on the same samples tests
3- Perform Atterberg limits for every triaxial test
4- Confining pressure shall be the in-situ total vertical stress at depth assessing the total vertical stress, typical unit weights for saturated assumed.
5- For soft soils only, request oedometer tests

8.4.3 GRANULAR SOILS

1- Measure in-situ unit weight and moisture content
2- Assess internal friction angle
3- Perform min/max densities with corresponding moisture content
4- Perform sieve analysis

SEQUENCE OF TESTS

EPCM Contractor's Representative will define the sequence of testing the priorities of the project.

9.0 DATA PROCESSING & FINAL REPORT

Data processing and reporting are considered of prime importance WORK.

STAGES OF DATA PROCESSING AND REPORTING

The several stages in data processing and reporting are divided as follows:

9.1.1 STAGE A: DATA ACQUISITION & FIELD REPORT

The raw data include :

- the electronic data (of laboratory, CPT, seismic, etc …) in proprietary and in AGS format
- all related factual data, extensively recorded in suitable log forms approved by the

EPCM Contractor. Hand written logs are acceptable at this stage if clear and well legible in English language (bilingual forms in English and Farsi are welcome if filed in English)

- lists of samples with all relevant details

Stage a data shall be delivered within 24 h following the acquisition as part of the Field Reporting, as described in paragraph 6.13.

Moreover, within two weeks after completion of the site work, Construction Contractor shall submit to EPCM Contractor a Field Report which gathers all factual data and information collected during the site work. A paper copy and an electronic version of the data shall be delivered in the appropriate formats.

The Field Report shall be delivered in hard (paper) copy (six hard copies) and in electronic format (proprietary, ,dxf, .dwg, MS Excel, AGS, etc …- pdf format is not accepted for plots, tables and data in general, plain text may be in .pdf format).

The Field report shall include:

- detailed description of operations and events
- detailed description of the equipment used (including calibration sheets)
- detailed description of the methodologies and standards applied
- all raw and processed data including sensors baselines (zeros), calibration factors, etc… in both tabulated and plotted format

- alignment sheets and plans in .dwg or .dxf format in local (project) coordinates

9.1.2 STAGE B: PROCESSED DATA

This stage includes all data correction and processing as per specifications, for each individual test or borehole. It includes:

- Corrected CPT plots in .DWG or .DXF and AGS format
- Preliminary Borehole Logs as per ASTM as prepared from the site description in a specialist professional software and in AGS format, including the collected samples o Laboratory test report sheet for individual tests, as prepared in a specialist professional software and in AGS format
- Geophysical Survey interpreted data and profiles in proprietary and AGS format o List of collected samples as input into the specialist professional software and in AGS format

Stage B shall be delivered within 14 days following the acquisition.

9.1.3 STAGE C: INTEGRATED DATA INTO A GEOTECHNICAL DATA MANAGEMENT SOFTWARE

All data are input as individual tests. The stage C is the integration of all data collected so far during the geotechnical and previous surveys, into the Geotechnical Data Management Software with their local (project) coordinates, delivered as alignment sheets, geological profiles, fences, plans, etc…, in proprietary, in AGS and in .dwg of. dxf format.

Stage C data include:

- The topographical information as provided by the topographical survey. Construction

  Contractor shall approach the EPCM Contractor to obtain up-to-date topographical data.

- the geological information as provided by the EPCM Contractor in AGS or .dxf/.dwg format
- the outcome of CPT tests, boreholes, trial pits, geophysical survey geotechnical walkover, and piezometers,
- Any other relevant information as collected by Construction Contractor or as provided by the EPCM Contractor.

Construction Contractor shall permanently maintain the Data Base up-to-date with 14 days of delay, which means that every data or information shall be integrated into the data base within 14 days after acquisition or collection. Construction Contractor shall deliver the Integrated Data in electronic format and in paper copy upon request from EPCM Contractor and every two weeks as a minimum.

9.1.4 STAGE D: EXTRAPOLATED DATA

The data from stage C are purely local, measured, observed and factual. Stage D is the extrapolation of all available data into soil models and lithologies, based on Engineering judgement and experience, outcome of the geological survey, results of the seismic and electro-magnetic survey, outcome of the geotechnical Walk-Over, etc…

The Extrapolated Data shall be delivered in the same form as the integrated data. The Extrapolated Data shall be delivered within one month of completion of site and laboratory work on every corridor branch.

9.1.5 STAGE E: DESIGN PARAMETERS

Design Parameters of an idealized soil model are proposed as believed to be representative of the behaviour of actual soil.

Stage E is not part of the present contract.

9.1.6 STAGE F: ENGINEERING, DESIGN AND RECOMMENDATIONS

Using the Design Parameters, engineering calculations are performed to answer the requirements of the project (foundation design, buoyancy control, settlement, slope stability, sand liquefaction assessment excavatability, trench stability, etc …)

CPTU DATA PROCESSING

CPTu data processing includes the adequate corrections and transformations of the data as per the industry standard and state-of-the-art. A good description of the applicable corrections and transformations to be applied is given in Cone Penetration Testing in Geotechnical Practice by T.LUNNE, P.ROBERTSON and J.POWEL, which shall be used as a reference for data processing and definition of parameters.

CPTu data acquisition and processing shall be performed with the software edited by the equipment manufacturer. Alternatively, commercially available software may be use d; in-house programs or spread sheets will not be accepted.

CPTu logs shall be provided in .dwg or .dxf AutoCAD format, in A4 individual sheets, with plots of tip resistance and friction in the same frame at standard scales, and plots of friction ratio, pore pressure and pore pressure ratio. Additionally, superimposed plots of tip resistance and friction at the standard scale (friction scale is 2.5% of tip resistance scale) shall be incorporated in the alignment sheets on a separate layer.

Additionally, CPT raw and processed data shall be delivered in electronic AGS format.

SOIL LOGS

Soil logs shall be provided in the reports as per ASTM and in AutoCAD .dwg or .dxf format.

Exact format shall be agreed with the EPCM CONTRACTOR. Soil log shall include on the same sheet:

- graphical representation of the soil as a column
- date of performance
- ground elevation
- top and bottom depth of every layer
- detailed lithology
- water table level
- water content and unit weights
- Atterberg limits
- Strength tests results (Cohesion and Angle of friction)
- Recovery for rocks
- Soil classification
- CPTu or SPT results
- UXO

ALIGNMENT SHEETS

The following results of the survey shall be plotted on separate layers in the geological profiles alignment sheets at scale in AutoCAD .dwg or .dxf format:

- Topographical data (coordinates of major points and elevation profile)
- Geological profile
- CPTu plots (tip resistance and friction superimposed at suitable scales)
- Borehole logs
- Geotechnical walk-over survey results
- Identification of geo-hazards area
- Measured water table level with date of measurement
- Rock strength laboratory results Vertical exaggeration and other format details shall be agreed upon with the EPCM CONTRACTOR.

PLANS

A plan of the area shall be prepared in AutoCAD .dwg or .dxf format with the following information on separate layers:

- pipe corridors
- topography (elevation curves)
- all geo-morphological and man made artefacts
- identified non-excavatable rock with indications of depths, whether on the surface or underground
- as agreed with EPCM CONTRACTOR

TABULATED RESULTS

In addition to the graphs, plots, plans, alignment sheets and logs, all results will also be delivered in electronic AGS format on a digital media (e.g. e-mail, CD-Rom, flash memory, etc…- floppy disks are not acceptable).

The following tables / spreadsheets shall be provided:

LOCATIONS

– reference documents for coordinates to be agreed upon with EPCM CONTRACTOR Corridor number, location number, coordinates of the theoretical location, coordinates of the actual location, target depth, actual depth.

CPTU DATA

Processed CPTu data shall be provided in columns, with all relevant information, and as a minimum: Corridor number, location number, theoretical and actual location coordinates depth, tip resistance, friction, friction ratio, excess pore pressure, pore pressure ratio.

CONDITIONED SAMPLES

All conditioned samples shall be extensively listed. The provided table shall include waxed samples, bag samples, Shelby tubes, etc … The table shall mention:

Corridor number, location number, sampling method, depth at top, depth at bottom, Summary soil description, type of conditioning.

LABORATORY TESTS RESULTS

The laboratory tests results table shall be prepared as per the examples provided in

ATTACHEMENT B and shall include:

Corridor number, location number, sampling method, depth at top, depth at bottom, Summary soil description, type of original conditioning, all laboratory tests results.

10.0 SUPERVISION

Contractor Representatives will be available on site for the monitoring of the work, issuance of Work Permits and Completion of Works Certificates.

Contractor reserves its right to have a full or part time supervision team checking the execution of the contract by Construction Contractor, even in its premises.

Shortly after award of contract, a Supervisor will visit Construction Contractor to assist and supervise:

- discuss and clarify specifications and scope of work
- organize vehicles and equipments safety and regulatory inspection
- discuss equipment upgrade
- establish operating procedures
- establish HSE procedures

The Supervisor will thus ensure equipment and procedures are acceptable before the start of the operations.

During the course of the site work, the supervisor will attend the site, and:

- monitor the correct implementation of the agreed procedures
- monitor the implementation of standards
- witness the progress and completed quantities
- select the samples for laboratory testing as far as practical
- receive the field and daily reporting
- analyse and assess the quality and reliability of the collected data
- direct the investigation and adjust the scope of work in the light of the outcome of the investigation
- liaise with EPCM Contractor to transmit the collected data and receive instructions

After completion of the site work, the supervisor will closely supervise the laboratory testing and the reporting as per requirements.

11.0 QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

Contractor Quality assurance shall comply with the requirements specified in IPS Iranian Petroleum Standards.

Details of non-compliance are to be made available to EPCM Contractor with the offer. Construction Contractor shall implement all specified quality assurance requirements and

exercise full and adequate quality control which includes the inspection and testing during

the execution of the work.

In addition, the field and home office works are also subject to intermediate and/or final inspection by EPCM Contractor.

12.0 CONTRACTOR PROVIDED ITEMS

PERSONNEL

Construction Contractor shall provide qualified personnel for the successful completion of the surveys.

EQUIPMENT & MATERIAL

12.2.1 EQUIPMENT

Construction Contractor shall provide all materials necessary to carry out the work in the time frame defined in the planning of the project..

All necessary spares required for the execution of the surveys shall be the responsibility of the Construction Contractor.

All equipment shall be properly calibrated before deployment and shall comply with the specifications.

Relevant calibration results shall be provided by Construction Contractor, if demanded by EPCM Contractor, to attest the fulfilment of these requirements.

12.2.2 MATERIAL

Construction Contractor shall provide all material necessary required for the execution of the work, except those that will be provided by the EPCM Contractor.

This shall include also (but not limited to) the consumable.

All materials shall be provided with adequate records and certificates and shall comply with the relevant Specification prior to mobilisation to site.

13.0 SAFETY

REGULATORY REQUIRMENTS

The Construction Contractor's attention is drawn to his responsibility for safe Practices and statutory requirement relating occupational safety and health.

Construction contractor shall be responsible for having its personnel adhering fully and permanently to all Safety Rules and regulations currently applicable to the Oil & Gas Industry and to EPCM Contractor's specifications.

Contractor shall comply to the following requirements and submit documents describing in detail how construction contractor intend to comply with them.

CONSTRUCTION CONTRACTOR HSE POLICY, ORGANIZATION, DOCUMENTS, REPORTING PROCEDURE AND OFFICERS

Construction contractor shall designate a project HSE manager, fully dedicated to implement and maintain good HSE conditions on the project.

On every site (rigs, guest houses, camps, offices, etc …) one educated worker shall be designated as HSE officer.

- There shall be at least one duly qualified first-aider per rig.
- Local workers, daily workers, and sub Construction Contractors are subject to the same requirements as Construction Contractor and Construction Contractor personnel.
- A list of all personnel involved in site activities shall be established and maintained up to-date, and made available to the EPCM Contractor. This includes side offices and guests houses

14.0 REQUIREMENT

- The Contractor shall provide all personnel, transport, equipment, materials tools, consumable etc., necessary to accomplish the work, and be totally self-supporting with respect to accommodation, messing etc. the work shall be supervised by a suitably qualified professional engineer, and all filed and laboratory personnel shall also be suitably qualified and experienced. Off-site testing shall be carried out in a well-established, recognized appropriate laboratory. The Contractor shall not commence work until advised by the client and all necessary permissions for access to site have been obtained.Contractor shall take care to avoid causing any damage to any existing property.

- Care shall be taken to ensure there are no live underground services at borehole, penetration test and trial pit locations.

- Care shall be exercised to ensure work undertaken does not interfere with overhead cables.
- All communications and information regarding the project shall be treated in the strictest confidence.
- Drilling of borehole
- Methods , filling of borehole , sampling & in situ testing
- Digging of trial pits or auger boring , piezometers , seismic hazard analysis(ASCE7-10)...,electrical resistivity tests
- Down holes, ground temp . , SRB, REPORTS