

DEP SPECIFICATION

ONSHORE AND NEARSHORE SITE INVESTIGATIONS

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the survey and site investigation activities required for obtaining data with respect to the physical site conditions, and is relevant to both onshore and nearshore projects.

This DEP relates to geological and geotechnical desk studies and field investigations, geophysical surveys and topographic and hydrographic surveys.

Assessment of contamination and environmental conditions is excluded from the scope of this DEP, since different standards apply to drilling equipment, sampling procedures, etc.

Metocean studies are also outside the scope of this DEP.

This is a revision of the DEP of the same number dated September 2011; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
Ground	Soil, rock and fill existing in place prior to the execution of the site investigation or construction project

Term	Definition
Made Ground	Non-engineered fill (of any type) placed as a result of human activity.
Survey Contractor	Party appointed by the Principal or the Contractor which carries out one or more of the site investigation activities.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (10).

1.5 SUMMARY OF MAIN CHANGES

This is a minor revision of the DEP of the same number dated September 2011. The main changes have been to update the project phasing terminology in line with the latest ORS. In addition, the required level of scoping for intrusive investigations has been revised to provide the required level of geotechnical data to enable efficient design to proceed.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

2. GENERAL CONSIDERATIONS

2.1 PURPOSE

A site investigation is carried out to acquire and interpret reliable information for one or more of the following aspects of a construction project:

- a) feasibility;
- b) site selection;
- c) basis for design;
- d) safe and economic design of temporary and permanent facilities;
- e) assessment of hazards associated with the ground;
- f) location of resources (e.g. sources of sand or aggregates);
- g) assessment of materials to be excavated or dredged;
- h) tendering and construction;
- i) operation and maintenance;
- j) extension/upgrading;
- k) de-commissioning;
- l) assessment of contamination (outside the scope of this DEP).

2.2 BASIC REQUIREMENTS

This DEP shall be applied to every site investigation.

Supplementary to this DEP, all work shall be carried out in accordance with recognised and accepted codes of practice and standards, and the principles of good engineering practice.

Examples of acceptable standards and codes of practice are given in this DEP.

2.3 UNITS OF MEASUREMENT

SI units shall be used for all surveys and related activities in accordance with DEP 00.00.20.10-Gen.

2.4 FINANCIAL CONSIDERATIONS AND EFFECTS

The timing for the soil investigation shall consider:

- a) Likelihood of the project proceeding beyond FID
- b) Sensitivity of design to soil investigation data
- c) Available soil investigation
- d) Remoteness of site
- e) Timing data is required
- f) Cost of mobilisation
- g) Remoteness of site

2.5 SITE INVESTIGATION & PROJECT PHASING

The type and scope of a site investigation depends on the purpose for which the investigation is required and on the circumstances under which it is to be carried out. The various types and scopes of site investigations are described in (6).

A site investigation shall consist of the following main elements:

- a) desk studies and walkover studies;

- b) remote sensing e.g. satellite imagery, aerial photography, LIDAR surveys.
- c) field surveys, such as boreholes, CPTs, in-situ tests, geophysical survey, visual inspection, measurements and sample collection;
- d) laboratory testing of samples collected during a field survey;
- e) data processing, integration and interpretation techniques for reporting purposes.

Consideration shall be given to:

- obtaining adequate site investigation data at an early stage in the project, as uncertainty about site conditions will be reflected in improved design of concept engineering and hence in reduced bid prices by Contractors;
- providing specialist supervision of the Survey Contractor's field survey activities, in order to help in ensuring that the technical and HSE objectives are met (e.g. by driving quality and adjusting the site investigation plan and detecting any deficiencies);
- preserving samples of ground or groundwater and retaining specific monitoring instruments for ongoing or future use.

3. TECHNICAL REQUIREMENTS

The Principal shall clearly define the objectives of the site investigation. This shall be in terms of required deliverables (e.g. geotechnical sections and design parameters, accuracy, level of definition of the ground and specific ground risks) and minimum scope of work. The objectives shall include a statement as to which phases of the project will be covered by the data from the site investigation.

The Principal shall prepare (or have prepared) a specification and scope of work, which will achieve the objectives. Alternatively, in some circumstances the Principal may delegate responsibility for the scoping, managing and interpreting a site investigation to the Geotechnical Consultant.

The Principal shall ensure the preparation and implementation of a project plan, in accordance with ISO 9004. The outline shall normally be provided by the Principal, with the details being undertaken by the Survey Contractor. The project plan shall include:

- a) a flexible approach that allows adjustment of the site investigation process, as information becomes available;
- b) clear lines of communication;
- c) a continuous chain of responsibility for the site investigation process and for decisions with respect to site conditions;
- d) details of equipment, survey methods, qualifications of personnel;
- e) full details of the execution programme; mobilisation times, fieldwork schedule and dates for deliverables.

The Survey Contractor shall keep the relevant parts of the specification, external standards, project plan, work instructions or method statements available for inspection at or near the place of the activities (for example at the site office, the laboratory and the Survey Contractor's office).

Since the Principal will normally supply the results of the factual site investigation to the main engineering Contractor as "rely-upon information", any data items not considered reliable shall be so marked.

3.1 CODES AND STANDARDS

3.1.1 General

As a minimum requirement, ISO Standards shall be employed for all site investigation and associated work. In addition, either British Standards (BS5930 and BS1377) or the equivalent. ASTM standards should be used.

In countries where prescriptive local codes apply that are mandatory, these shall be employed. However, unless the local codes are deemed to be sufficiently robust to apply in isolation, works shall also be duplicated in accordance with the BS or ASTM standard.

The use of measuring equipment during geotechnical field investigations shall be in accordance with ISO 10012.

DEP 34.11.00.12-Gen. sets out requirements for geotechnical design and analysis.

3.1.2 North America

In North America the geotechnical investigations shall conform to the applicable codes, standards, specifications and government regulations, including those listed below. Each document shall be the latest revision and addendum, including supplements, if any:

ASTM	ASTM D2487
CGS	Canadian Foundation Engineering Manual
IEEE	Standard Guide for Soil Thermal Resistivity Measurements
Provincial Authority	Occupational Health and Safety Regulations (OH&S)

Whenever a conflict exists among the referenced costs, standards and specifications, the more stringent shall apply unless specifically noted otherwise in the project documents.

3.2 DESIGN STRATEGY

3.2.1 Extent of investigation required

The extent of information required depends on the nature and complexity of the facilities to be constructed, the nature and complexity of the ground and the acceptable risk level (related to direct effects and economic damage that can result).

The site investigation will include some or all of the survey types described in this document and will in general be phased. The level of detail shall be appropriate to satisfy the objectives of the site investigation.

3.2.2 Minor projects

For small projects and small extensions to existing facilities and structures, available survey (or design) data may be used. If any doubt exists regarding the accuracy of the existing data, it shall be verified by means of a 'verification investigation'. Depending on the scope of the project, this may vary from a detailed site investigation to inspection of the exposed base of an excavation for a shallow foundation, supplemented by manual testing.

3.2.3 Projects with an "over-water" component

If there is surface water in the area to be investigated, the cost of the site investigation will be substantially greater than that of a similar dry-land project. Mobilisation, moving, access and standby costs are generally much higher. The inter-tidal zone causes particular problems because it can be difficult to reach with either onshore or marine equipment.

Consideration shall be given to factors such as:

- minimising the number of site investigation phases of a nearshore site investigation because of the limited availability and high mobilisation cost of adequate floating craft and special field survey apparatus;
- progress is often closely dependent on tides, currents, weather conditions and safety aspects;

- feasibility and timing of a geophysical survey is particularly important with respect to the scope of the geotechnical survey.
- geophysical and hydrographic survey data may be acquired simultaneously from the same vessel.

HSE risks should be addressed in accordance with current Shell standards and should include proper marine inspections by suitably qualified staff.

3.2.4 Procurement of site investigation/survey contracts

Tenderers shall be pre-qualified on the basis of the scope of the work, their technical and HSE expertise and experience of local ground conditions. Prequalification procedures should include submissions covering experience, proposed staff, equipment, work methods etc. by the Contractor (for known Contractors these submissions can be left until the tender), and consultation with others who have used the Contractor.

Enterprises and personnel shall conform to ISO/TS 22475-2:2006 or ASTM D 3740 in North America.

Interpretative reporting responsibilities should only be awarded to organisations that have competent staff available to do the work, and that can provide assurances that these staff will be available when planned.

A good geotechnical interpretative report should in general only be written by someone who has been on site and seen the ground first hand. Descriptions by others are usually subjective and rarely convey full details of the site.

3.2.5 Procurement of site investigation specialists

Specialist expertise may have to be procured for:

- carrying out desk studies;
- supervision of field work;
- review of Survey Contractor submissions;
- design review.

3.3 SITE INVESTIGATION REPORTING REQUIREMENTS

The essential reporting requirements shall be specified and shall include:

- a) the purpose of the report;
- b) summary descriptions of work carried out, adopted practice, procedures or method statements, with references to external standards where appropriate;
- c) a list of previous site investigations carried out at the site and sources of information consulted;
- d) results; geological descriptions, exploratory hole records, in-situ and laboratory test results, geophysical results;
- e) maps;
- f) interpretation of results, where required;
- g) hard copies of draft and final report;
- h) electronic copy of final report in Adobe Acrobat (*.pdf format);
- i) digital copy of the final factual report data, including all exploratory hole data, field and laboratory testing in either ASCII or AGS data format;
- j) comments on circumstances that may lead to defective, irrelevant, insufficient or inaccurate data.

If the reliability of the conclusions and recommendations may be inhibited by insufficient tangible evidence or experience, the Survey Contractor shall identify where additional studies are required in order to provide the required degree of confidence.

Particular consideration shall be given to specification of the scope (number and type of analyses, detailed advice, recommendations etc.) and the required level of detail and sophistication of interpretative analysis. This promotes:

- reduction of bid uncertainties incorporated in proposals by potential Survey Contractors;
- ready evaluation of proposals of Survey Contractors; and
- adequate checks of completed activities.

The basic types of site investigation reports are:

- a) desk study report;
- b) daily field (or laboratory) report (typically hand written logs, etc.);
- c) weekly field (or laboratory) report (normally typed);
- d) final field report (not normally required if weekly reports have been submitted);
- e) draft and final factual report;
- f) draft and final interpretative report.

The need for a particular type of report depends on the survey requirements and the nature of the project. For example, daily reports on a geotechnical survey are useful where preliminary information is urgently required for design or for determining the magnitude of further site investigation.

Presentation of field data consists of operational information and preliminary factual data.

Interpretative reporting shall include appropriate evaluation of the factual data. In particular, anomalous data shall be considered carefully in order to determine whether it is misleading or represents a real phenomenon that requires further investigation. The presentation of interpretative information may include sketches, photographs, plans and drawings, cross-sections, contour plans, tabular and graphical data. Complex projects may require video presentations, 3-D computer models and Geographical Information Systems.

3.4 HEALTH, SAFETY AND ENVIRONMENT

All work shall be carried out in a safe manner in accordance with Shell Health, Safety and Environmental (HSE) standards. All relevant health, safety and environmental warnings in the applicable internal and external standards shall be heeded.

It should be realised that site investigation equipment and procedures are by their nature higher risk than most, as work takes place in unprepared locations, with numerous lifts of (heavy) equipment, in the presence of slippery drilling fluids etc. Hence, safety and safe-thinking must be a priority if accidents are to be avoided.

At the tender stage, each tenderer shall submit an HSE plan, focused on the work tendered for. This shall include an HSE Manager who shall be mobilised to site with the first personnel. Potential Contractors' HSE records shall be included in prequalification/tender evaluation. An unsatisfactory HSE record shall be grounds to disqualify a Contractor.

The Contractor shall prepare a full HSE plan after contract award which reflects the specific details of the full scope of work.

4. DESK STUDY & WALKOVER

4.1 DESK STUDY

A desk study shall be undertaken to obtain a good understanding of the likely ground conditions at a site on the basis of existing published and pre-existing site data.

The Desk Study shall include the development of a Conceptual Site Model (CSM). This incorporates key elements of the site conditions into a framework that once established, can be refined and developed as conditions at the site become better defined.

At Desk Study stage, the CSM should typically incorporate the following elements:

- a) The general topography of the site.
- b) Aerial photography or high resolution satellite imagery of the site.
- c) The probable stratigraphic sequence at the site.
- d) The probable lateral and vertical distribution of different geological materials across the site.
- e) The probable hydrogeological regime at the site.
- f) The probable locations of any geohazards identified from existing data (faults, soft ground, slope instability, cavities etc.).

In situations where limited information is available for a site, the formulation of the CSM will require assumptions to be made. In general, the assumptions should reflect the simplest model that is consistent with the available data. The uncertainties associated with the CSM are highlighted in the Desk Study report to be addressed by subsequent investigations.

The Desk Study Report is typically incorporated into the Geotechnical Data Acquisition Plan.

The Desk Study report shall include:

- i. Site location and general description
- ii. Description of topography
- iii. Description of morphology
- iv. List of sources of information
- v. Conceptual Site Model
- vi. Identification of uncertainties and inconsistencies
- vii. Description of expected materials
- viii. Summary of likely material properties (if possible)
- ix. Description of likely groundwater regime
- x. Identification of potential geohazards
- xi. Preliminary geotechnical recommendations
 - Site preparation
 - Foundations
 - retaining structures
 - roads
 - Infrastructure
 - Groundwater control
- xii. Recommendations for Site Investigation
- xiii. Identification of any specialist studies required

- xiv. Availability of resources such as aggregate, structural fill etc.
- xv. Maps in which the above mentioned data and analysis results have been integrated

4.2 WALKOVER STUDY

A walkover study shall be undertaken by an experienced Engineer/Engineering Geologist in advance of any Site Investigation works, where practically feasible.

The walkover shall provide the following useful information that may be technically relevant to the site development:

- a) Topography: gradients, breaks of slope, low-lying ground, possible landslip back-scarp features.
- b) Land-use: Existing structures, type of ground cover, conditions of ground cover, industrial or agricultural processes, drainage.
- c) Vegetation: tress (age, size and conditions), plants/grass (type, state and changes across the site), any barren areas, any marshy or soft areas.
- d) Filled Areas: Any areas of obvious fill, type of fill (engineered versus non-engineered), evidence of old borrow pits, unstable ground, evidence of contamination or potentially contaminative processes.
- e) Ground conditions: rock exposures in outcrops or existing slopes or excavations, evidence of soft ground, marsh, hummucky ground, evidence of solution features, collapsed ground, evidence of duricrust, windblown sand, salt and evaporate material present.
- f) Groundwater; existing surface water drainage, man-made and natural, standing water, spring-lines, any evidence of water ponding (indicating low hydraulic conductivity near-surface material), evidence of groundwater abstractions.

Where relevant the data gathered in the field shall be used to ground through previously acquired satellite imagery with the aim to allow computerised classification of the imagery.

In addition to the information above, the walkover shall also provide information that can assist in scoping any site investigation, allowing methods to be optimised and delays/cost-overruns to be avoided. Useful observations include:

- Access constraints: Is the site accessible? Is there sufficient infrastructure to allow mobilisation by road or is marine access required? Can the site be trafficked by plant and equipment or are temporary roadways or access mats required? Are there any headroom restrictions? Will site clearance or demolition be required in advance of site investigation work?
- Services: Is there evidence of any buried or above ground services (pipelines, underground storage tanks, manhole covers)? Can these services be traced?
- Stability: Is there evidence of soft or unstable ground that may pose problems for conventional site investigation equipment? Will there be a need for low-ground pressure (crawler) rigs; will a temporary working platform be required? Is the site subject to flooding or within an intertidal zone?
- Environmental: Is there any evidence that the site provides a natural habitat that could be jeopardised by the works?

The site visit/walkover study shall also provide information useful to the project such as; logistics requirements, permitting, access difficulties, local contractors, utilities information. The walkover should be undertaken by suitably experienced persons.

The findings of the walkover study shall be incorporated into the Geotechnical Data Acquisition Plan and should include field maps, sketches, photographs and records of any field measurements or observations.