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NATIONAL IRANIAN OIL REFINING & DISTRIBUTION COMPANY
NATIONAL IRANIAN OIL ENGINEERING
& CONSTRUCTION COMPANY

NIOEC SP

NIOEC SPECIFICATION FOR SOIL ENGINEERING AND GROUND INVESTIGATIONS

SECOND EDITION

DECEMBER , 2016

THIS SPECIFICATION IS THE PROPERTY OF NATIONAL IRANIAN OIL ENGINEERING & CONSTRUCTION COMPANY. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED TO THE OWNER. NEITHER WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR BY ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF THE NATIONAL IRANIAN OIL ENGINEERING & CONSTRUCTION COMPANY.

IN THE NAME OF GOD**FOREWORD**

By their very nature, technical Specifications are continuously subject to modifications and revisions. To strengthen their merit and usefulness, continuous improvements, addendum, deletion of disparate information and consequently provision of updated revisions are to be made in order to ascertain that such Specifications meet the current requirements, inclusive of Iranian Petroleum Standards (IPS) and the recognized and acceptable national and international Standards, as well as the optimal codes and practices based on the accumulated in-house know-how and plant knowledge and experiences.

However, in reality, due to several reasons, not to mention the complexity of the matter, the ultimate goal of continuous direct embedment of the required changes on the relevant Specifications may be far reaching. Therefore, in the interim periods between the officially issued revisions, the required changes will appear in other documents related to the engineering and design work of the ongoing projects.

In response to the initiative of the Design and Engineering Directorate, and considering that the task of the execution of several important and mega projects for the realization of the new oil refineries, pipelines and oil terminals as well as improvements of the existing facilities, has been assigned to NIOEC, it was decided to update the NIOEC Specifications and to issue new official revisions.

The Design and Engineering Directorate was itself entrusted to carry out this important task, and as such by forming several special technical committees, working in close co-operation and cohesion and sharing their expertise and knowledge, the updated and revised NIOEC Specifications were successfully prepared and complied.

These Specifications are intended to be used for Oil Refineries, Distribution Depots, Oil Terminals, Pipelines and Pump Stations within NIOEC's projects, and have been proven to be of high value for such purposes. It must however be appreciated that these Specifications represent the minimum requirements and should in no way be interpreted as a restriction on the use of better procedures, engineering and design practices or materials.

We encourage and highly appreciate the users and other clear sighted and experts to send their comments on the Specifications to the Design and Engineering Director of NIOEC for evaluation and approval.

REVISION INDEX

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NOTES:

- 1) THIS SHEET IS A RECORD OF ALL REVISIONS TO THIS SPECIFICATION.
- 2) WHEN APPROVED EACH REVISION SHALL BE CONSIDERED AS A PART OF THE ORIGINAL DOCUMENT.
- 3) NUMBER OF PAGES EXCLUDES THIS SHEET AND THE COVER SHEET.

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1. SCOPE

This NIOEC Specification sets out rules and procedures which are necessary for geotechnical investigations including planning of subsurface explorations, sampling, field and laboratory tests on soil, rock and groundwater, controlling and monitoring on execution of works, ground investigation and geotechnical design report. Executive criteria such as number, locations and depths of boreholes are determined in scope of work attached to each geotechnical contract according to specified conditions of each project.

This Specification is mainly adapted from BS EN 1997-2(2010) "as major reference" that is emphasized on important clauses herein after and completed by additional principals such as dynamically loaded soil tests.

Deviations from this Specification will only be permitted on obtaining written approval from NIOEC.

Resolution on cases not explicitly stipulated in this Specification, or on cases where conflicts may arise among the requirements of the referenced/relevant IPS and the international standards, shall be made through written consent and approval of NIOEC.

2. REFERENCES

The following standards, codes, and specifications, to the extent specified hereinafter, shall constitute a part of this NIOEC Specification. Latest edition of the undated referenced documents and the cited edition of the dated references shall apply. The applicability of changes made to the dated references after the cited date shall be mutually agreed upon between NIOEC and the Vendor/Contractor.

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM Vol. 04.08	"Building Stones; Geotextiles"
ASTM D653	"Terminology Relating to Soil, Rock, and Contained Fluids"
ASTM D341	"Viscosity-Temperature Charts for Liquid Petroleum Products"
ASTM D1883	"Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils"
ASTM D2167	"Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method"
ASTM D2434	"Test Method for Permeability of Granular Soils"
ASTM D2487	"Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)"
ASTM D2850	"Test Method for Unconsolidated-Un drained Tri axial Compression Test on Cohesive Soils"
ASTM D2922	"Test Methods for Density of soil and soil-Aggregate in Place by Nuclear Methods (Shallow Depth)"
ASTM D3441	"Test Method for Mechanical Cone Penetration Tests of Soil"
ASTM D3999	"Test Methods for the Determination of the Modulus and Damping Properties of Soils Using the Cyclic Triaxial Apparatus"

ASTM D4015	"Test Methods for Modulus and Damping of Soils by the Resonant-Column Method"
ASTM D4221	"Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer"
ASTM D4254	"Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density"
ASTM D4381	"Test Method for Sand Content by Volume of Bentonitic Slurries"
ASTM D4412	"Test Methods for Sulfate-Reducing Bacteria in Water and Water Formed Deposits"
ASTM D4428	"Test Methods for Crosshole Seismic Testing"
ASTM D4525	"Test Method for Permeability of Rocks by Flowing Air"
ASTM D4644	"Test Method for Slake Durability of Shales and Similar Weak Rocks"
ASTM D4647	"Test Method for Identification and Classification of Dispersive Clay Soils by the Pinhole Test"
ASTM D4767	"Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils"
ASTM D4829	"Test Method for Expansion Index of Soils"
ASTM D5311	"Test Method for Load Controlled Cyclic Triaxial Strength of Soil"
ASTM D5334	"Test Method for Determination of Thermal Conductivity of Soil and Soft Rock by Thermal Needle Probe Procedure"
ASTM G57	"Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method"
ASTM D5777	"Guide for Using the Seismic Refraction Method for Subsurface Investigation"
ASTM D5778	"Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils"
ASTM D6938	"Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)"
ASTM D7012	"Test Method for Compressive Strength and Elastic Module of Intact Rock Core Specimens under Varying States of Stress and Temperatures"
ASTM D7070	"Test Methods for Creep of Rock Core under Constant Stress and Temperature"
ASTM D7400	"Test Methods for Downhole Seismic Testing"
ASTM D7128	"Guide for Using the Seismic-Reflection Method for Shallow Subsurface Investigation"
ASTM STP 984	"Rock Classification System for Engineering Purposes"

**AASHTO (AMERICAN ASSOCIATION OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS)**

AASHTO M 145-91 "Classification of Soils and Soil-Aggregate Mixtures for
Highway Construction Purposes"

BSI (BRITISH STANDARDS INSTITUTION)

BS 1377: Parts 1 to 9: 1990 "Methods of Tests for Soils for Civil Engineering Purposes"

BS 1881: 1988 Part 124 "Methods for Analysis of Hardened Concrete"

BS 1997-1: 2004 "Eurocode 7 - General rules"

BS 1997-2: 2010 "Eurocode 7 - Geotechnical design; Part 2: Ground
investigation and testing"

BS 6031: 1981 "Code of Practice for Earthworks"

BS 8004: 1986 "Code of Practice for Foundations"

BS 22475-1:2007 "Geotechnical investigation and testing-Sampling methods
and groundwater measurements; Part 1: Technical principles
for execution"

EN ISO 22476 "Geotechnical investigation and testing"

DIN (DEUTSCHES INSTITUTE FOR NORMUNG)

DIN 52104: 1982 "Testing of Natural Stone Freeze-Thaw Cyclic Part 1 & 2 Test"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-CE-110 "Engineering Standard for Soil Engineering"

NIOEC-SP (NIOEC-SPECIFICATION)

NIOEC-SP-00-10 "NIOEC Specification for Units"

NIOEC-SP-80-24 "NIOEC Specification for Cathodic Protection of Buried and
Submerged Structures"

3. UNITS

International system of unites (SI) shall be used in accordance with NIOEC-SP-00-10, unless otherwise specified.

4. DEFINITIONS & TERMINOLOGY

Soil and rock mechanics terms are defined in ASTM D653, definition of terms related to soil testing is given in BS 1377: Part 1:1990.

5. PLANNING OF GROUND INVESTIGATIONS

5.1. Objectives of Ground Investigations

Required information in this specification will further be completed by the results of laboratory tests on soil and rock samples so that it will be possible to assess such considerations as bearing capacity and settlement of foundations, stability of slopes in embankments and cuttings, earth pressures on supporting structures and the effect of any chemically aggressive ground conditions.

5.2. Ground Investigation Sequences

Ground investigations shall normally be performed in phases depending on the questions raised during planning, design and construction of scope of work in each project. The following phases are treated separately:

- Preliminary investigations for positioning and preliminary design of the structure (see 5.2.1);
- Design investigations (see 5.2.2);
- Controlling and monitoring (see 5.2.3).

5.2.1. Preliminary Investigations

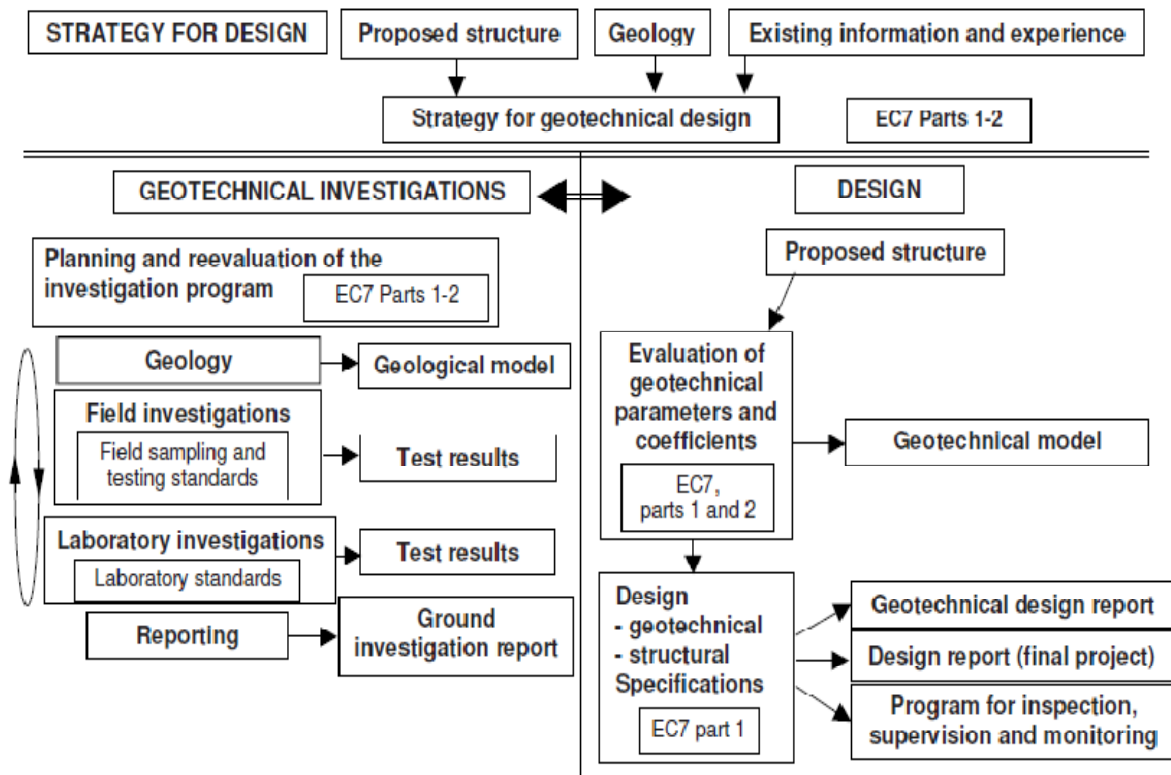
- 1) Before commencing ground investigation, all relevant information including ground conditions, geology, geomorphology, seismicity, hydrogeology and climatology should be collected, reviewed and considered together in order to obtain a preliminary conception of the ground conditions and the engineering problems that may be involved.
- 2) The preliminary investigations should be planned in such a way that adequate data are obtained, if relevant, to:
 - Assess the overall stability and general suitability of the site;
 - Assess the suitability of the site in comparison with alternative sites or paths;
 - Assess the suitable positioning of the structure;
 - Evaluate the possible effects of the proposed works on surroundings, such as neighboring buildings, structures and sites;
 - Identify borrow areas;
 - Consider the possible foundation methods and any ground improvements;
 - Plan the design and control investigations, including identification of the extent of ground which may have significant influence on the behavior of the structure.
- 3) A preliminary ground investigation shall supply estimates of soil data concerning, if relevant:
 - The type of soil or rock and their stratification;
 - The groundwater table or pore pressure profile;
 - The preliminary strength and deformation properties for soil and rock;
 - The potential occurrence of contaminated ground or groundwater that might be hazardous to the durability of construction material.
 - Determining factors on selection of methods for ground investigation.

5.2.2. Design Investigations

Figure 1 gives a general guidance for Stages of ground investigations in geotechnical design investigations for execution of works.

Figure 1: Stages of Ground Investigations and Geotechnical Design

(BS EN1997-2, 2010)



5.2.2.1. Field Investigations

1) Field investigations in the design phase shall comprise:

- Drilling and/or excavations (in soil and rock sampling for description of the soil or rock and laboratory tests and gathering of information where ever ground contamination or soil gas is), see clause 7.
- Groundwater measurements (including pore pressure profile and their fluctuations); further details on field tests are given in clause 7.
- Field tests (including geophysical investigations and large scale tests); further details on field tests are given in clause 8.

2) The field investigation program shall contain:

- A plan with the locations of the investigation points including the types of investigation;
- The depth of the investigations;
- The types of sample (category, etc.) to be taken including specifications for the number and depth at which they are to be taken;