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

# NIOEC SP

NIOEC SPECIFICATION

FOR

## FOUNDATION AND DIKE FOR STORAGE TANKS

SECOND EDITION

JULY, 2009

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.

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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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| 5    |            |                |               |                 |                    |
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| 3    |            |                |               |                 |                    |
| 2    | JUNE, 2015 | M.MEHRAJI      | Z.GHETMIRI    | M.KARGAR NAJAFI | A.R.ARMAN MOGHADAM |
| 1    | JULY, 2009 | S.A.MIRSHARIFI | S.M.J.SHEYEDI | M.R.FARZAM      | M.A.A.SAJEDI       |
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## 1. SCOPE

This Specification covers the minimum requirements for materials, design and construction of generally occurring foundations for vertical cylindrical aboveground welded storage tanks for atmospheric pressure. It does not apply to refrigerated, cryogenic, pressured or corrosive chemical storage tanks.

### 1.1. This Specification includes:

- Excavation as required and supply and installation of all fill material, gravel and Asphaltic concrete for tank foundations.
- Disposal of surplus excavated material.
- Application of weed killer to the sub grade.
- Dike and diked area

### 1.2. Items excluded from this specification:

- Rough grading

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.

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

|             |                                                                                                                             |
|-------------|-----------------------------------------------------------------------------------------------------------------------------|
| AASHTO T180 | “Standard Method of Test for Moisture-Density Relations of Soils using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop” |
|-------------|-----------------------------------------------------------------------------------------------------------------------------|

### **ACI (AMERICAN CONCRETE INSTITUTE)**

|         |                                                      |
|---------|------------------------------------------------------|
| ACI 318 | “Building Code Requirements for Structural Concrete” |
|---------|------------------------------------------------------|

### **API (AMERICAN PETROLUM STANDARD)**

|             |                                                           |
|-------------|-----------------------------------------------------------|
| API STD 650 | “Welded Tanks for Oil Storage”                            |
| API STD 653 | “Tank Inspection, Repair, Alteration, and Reconstruction” |

### **ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)**

|           |                                                             |
|-----------|-------------------------------------------------------------|
| ASTM C33  | “Standard Specification for Concrete Aggregates”            |
| ASTM D422 | “Standard Test Methods for Particle-Size Analysis of Soils” |

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|            |                                                                                                                                                              |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM D448  | “Standard Classification for Sizes of Aggregate for Road and Bridge Construction”                                                                            |
| ASTM D693  | “Standard Specification for Crushed Aggregate for Macadam Pavements”                                                                                         |
| ASTM D6938 | “Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (shallow Depth)”                                 |
| ASTM D2167 | “Standard Test Methods for Density and Unit Weigh of Soil in Place by the Rubber Balloon Method”                                                             |
| ASTM D4253 | “Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table”                                                           |
| ASTM D2937 | “Standard Test Methods for Density of Soil in Place by the Drive-Cylinder Method”                                                                            |
| ASTM D4254 | “Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density”                                               |
| ASTM D1557 | “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft <sup>3</sup> (2,700 kN-m/m <sup>3</sup> ))” |
| ASTM D1556 | “Standard Test Methods for Density and Unit Weight of Soil in Place by the Sand-Cone Method”                                                                 |
| ASTM D1241 | “Standard Specification for Materials for Soil-Aggregate Sub base, Base, and Surface Courses”                                                                |
| ASTM D2922 | “Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)”                                                    |

### NIOEC SP (NIOEC SPECIFICATIONS)

|                |                                                                                  |
|----------------|----------------------------------------------------------------------------------|
| NIOEC-SP-00-01 | “NIOEC Specification for Civil Design Criteria”                                  |
| NIOEC-SP-00-02 | “NIOEC Specification for Site Preparation Earthwork and Sewers”                  |
| NIOEC-SP-00-05 | “NIOEC Specification for Excavation and Backfill for Civil Work”                 |
| NIOEC-SP-00-10 | “NIOEC Specification for Units”                                                  |
| NIOEC-SP-00-53 | “NIOEC Specification for Layout and Spacing”                                     |
| NIOEC-SP-10-01 | “NIOEC Specification for Concrete”                                               |
| NIOEC-SP-10-12 | “NIOEC Specification for Piles”                                                  |
| NIOEC-SP-10-17 | “NIOEC Specification for Soil Engineering”                                       |
| NIOEC-SP-80-24 | “NIOEC Specification for Cathodic Protection of Buried and Submerged Structures” |

### NIOEC SD (NIOEC-STANDARD DRAWINGS)

|                   |                                    |
|-------------------|------------------------------------|
| NIOEC-SD-1011-1~3 | “Bund Walls, Steps & Pipe Sleeves” |
|-------------------|------------------------------------|

### 3. UNITS

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

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#### 4. EXCAVATION & BACKFILL

Site preparation, excavation and backfill for foundation, dikes and diked area for storage tanks carried out in accordance with NIOEC-SP-00-02 & NIOEC-SP-00-05.

The excavation shall conform to the dimensions and elevations indicated on the drawings.

#### 5. GENERAL

- 5.1. The Contractor shall furnish all materials, tools, equipment, utilities, facilities, etc., and shall perform all labor and services necessary for the proper execution and completion of foundations for storage tanks, all as shown on the drawings, as specified herein and / or reasonably implied thereby to carry out the apparent intent of the work.
- 5.2. The type of tank foundations and ground improvement shall be specified in basic design based on Geotechnical Investigation Report.
- 5.3. The design of tank foundations shall be based on the advice and design parameters given in the Geotechnical Investigation Report(s), and API 650.
- 5.4. All anticipated settlements and deformations of the foundation shall be reviewed by specialist civil/structural. Tank/vessel and Piping Engineers employed by the Contractor in order for them to assess if the anticipated movement of the tank is acceptable for the design of the tank and the tank piping attachments.

#### 6. TYPES OF TANK FOUNDATION

Depending on the situations and soil conditions several types of foundations may be utilized, among which the following may be stated:

- Earth Foundations without a Ringwall;
- Earth Foundations with a Concrete Ringwall;
- Earth Foundations with a Crushed-Stone and Gravel Ringwall;
- Slab Foundations (with or without piles);

For more information about tank foundation see Appendix B-API 650.

##### 6.1. Earth Foundations without a Ringwall

- 6.1.1. When an engineering evaluation of subsurface conditions that is based on experience and/or exploratory work has shown that the subgrade has adequate bearing capacity and that settlements will be acceptable, satisfactory foundations may be constructed from earth materials. The performance requirements for earth foundations are identical to those for more extensive foundations. Specifically, an earth foundation should accomplish the following:
  - a) Provide a stable plane for the support of the tank.
  - b) Limit overall settlement of the tank grade to values compatible with the allowances used in the design of the connecting piping.
  - c) Provide adequate drainage.
  - d) Not settle excessively at the perimeter due to the weight of the shell wall.
- 6.1.2. Many satisfactory designs are possible when sound engineering judgment is used in their development. For smaller tanks, foundations can consist of compacted crushed stone, screenings, fine gravel, clean sand, or similar material placed directly on virgin soil. Any unstable material must be removed, and any replacement material must be thoroughly compacted.