

NIOEC-SP-10-01(2)							
DOCUMENT CODE							NO. OF SHEETS:36
PLAN/PRJ/SUB	UNIT	PHASE	DISCIPLINE	DOCUMENT. TYPE	SERIAL NO.	REV. NO.	DATE
NIOEC	000	EG	CE	SP	1001	A2	JUNE, 2017



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

NIOEC SP

NIOEC SPECIFICATION FOR CONCRETE

THIRD EDITION

JUNE, 2017

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

REV. PAGE	1	2	3	4	5	REV. PAGE	1	2	3	4	5	REV. PAGE	1	2	3	4	5	REV. PAGE	1	2	3	4	5
1	x	x				26		x				51						76					
2	x	x				27	x	x				52						77					
3	x	x				28		x				53						78					
4	x	x				29		x				54						79					
5	x	x				30		x				55						80					
6	x	x				31		x				56						81					
7	x	x				32		x				57						82					
8	x	x				33		x				58						83					
9	x	x				34		x				59						84					
10	x	x				35		x				60						85					
11	x	x				36		x				61						86					
12	x	x				37						62						87					
13	x	x				38						63						88					
14	x	x				39						64						89					
15	x	x				40						65						90					
16	x	x				41						66						91					
17	x	x				42						67						92					
18	x	x				43						68						93					
19	x	x				44						69						94					
20	x	x				45						70						95					
21	x	x				46						71						96					
22	x	x				47						72						97					
23	x	x				48						73						98					
24	x	x				49						74						99					
25	x	x				50						75						100					

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.

5					
4					
3					
2	JUNE, 2017	SH. HAJILOO	Z.GHETMIRI	M.R.FARZAM	M.KAREGAR NAJAFI
1	JULY, 2009	CIVIL DIS	S.M.J.SYEDI	M.R.FARZAM	M.A.A.SAJEDI
0	JULY, 2005	Z.GHETMIRI	S.M.J.SYEDI	M.R.FARZAM	M.A.A.SAJEDI
REV.	DATE	PREPARED	CHECKED	APPROVED	AUTHORIZED

CONTENTS:	PAGE NO.
1. SCOPE.....	3
2. REFERENCES.....	3
3. UNITS.....	6
4. GENERAL.....	6
5. MATERIALS	7
5.1. Test of Materials.....	7
5.2. Cement.....	8
5.3. Supplementary Cementitious Materials	8
5.4. Aggregates	8
5.5. Water	8
5.6. Admixtures	8
5.7. Steel Reinforcement.....	9
5.8. Storage of Materials	9
6. PROPORTIONING	9
6.1. Selection of Concrete Proportioning.....	9
6.2. Slump	9
6.3. Maximum Size of Coarse Aggregate.....	9
7. FORMWORK	10
8. REINFORCEMENT	12
9. Tolerances.....	12
10. JOINTS IN CONCRETE.....	13
10.1. General.....	13
10.2. Joints in Concrete Structure	13
10.3. Joints in Concrete Slabs-on-Ground.....	14
10.4. Joints in Liquid-Containing Structures.....	14
11. EMBEDDED ITEMS.....	15
11.1. Anchor Bolts	15
11.2. Waterstops	15
11.3. Joint Filler and Joint Sealants	15
11.4. Other Embedded Items	16
11.5. Placing Embedded Items.....	16
12. MIXING	16
12.1. Measuring Amounts of Materials for Mixing.....	16
12.2. Ready-Mixed Concrete	16
12.3. Batch Mixing at Site	17
12.4. Retempering	17
12.5. Hot Weather Concreting	17
12.6. Cold Weather Concreting	18
13. DURABILITY REQUIREMENT.....	18
13.1. Exposure Categories and Classes.....	18

13.2. Requirements for Concrete Mixtures	Error! Bookmark not defined.
14. ADMIXTURES, THEIR CHARACTERISTICS, AND USAGE	23
15. CONCRETE PROTECTION FOR REINFORCEMENT	25
15.1. Cast-In-Place Concrete (non pre-stressed)	25
15.2. Precast Concrete (manufactured under plant control conditions)	25
15.3. Pre-stressed Concrete-Cast in Place	26
15.4. Bundled Bars	26
15.5. Corrosive Environments	27
15.6. Future Extensions	27
15.7. Fire Protection	27
16. PLACING	28
16.1. Conveying	28
16.2. Depositing	28
16.3. Placing Temperature	28
16.4. Bonding	29
17. FINISHING	29
17.1. Formed Concrete	29
17.2. Flat Work (Unformed Concrete)	29
17.3. Finished Concrete Surfaces	30
18. CURING	30
18.1. General	30
18.2. Curing Procedures	30
18.3. Initial Curing	30
18.4. Final Curing	30
18.5. Termination of Curing	30
18.6. Formed Surface	31
18.7. Hot and Cold Weather Curing	31
19. GROUTING	31
19.1. Placing Grouted and Dry Packed Items	31
19.2. Grouting Procedures	31
19.3. Types of Grout	31
20. TESTING AND QUALITY CONTROL	32
20.1. Responsibilities and Duties of the Contractor	33
20.2. Testing of Concrete	33
20.3. Records	34
21. CONCRETE PAVING	35
21.1. Subgrade and Base Requirement	35
21.2. Concrete Paving Requirement	35
22. INSPECTION	36

1. SCOPE

This Specification defines minimum requirements for Design and Construction of reinforced Concrete structures and material characteristics, proportioning, concrete characteristics, in-situ checks and tests, and all related documents to concrete works.

This specification shall be applied only to normal density concrete.

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.

ACI (AMERICAN CONCRETE INSTITUTE)

ACI 117M	"Specification for Tolerances for Concrete Construction and Materials and Commentary"
ACI 201.2R	"Guide to Durable Concrete"
ACI 211.1	"Standard Practice for Selecting Proportions for Normal, Heavy Weight and Mass Concrete"
ACI 212.3R	"Report on Chemical Admixtures for Concrete"
ACI 212.4R	"Guide for the Use of High-Range Water Reducing Admixtures (Super Plasticizers) in Concrete"
ACI 222.R	"Protection of Metals in Concrete against Corrosion"
ACI 224.3R	"Joints in Concrete Construction"
ACI 225R	"Guide to the Selection and Use of Hydraulic Cement"
ACI 232.1R	"Report on the Use of Raw or Processed Natural Pozzolans in Concrete"
ACI 232.2R	"Use of Fly Ash in Concrete"
ACI 233R	"Slag Cement in Concrete and Mortar"
ACI 234R	"Guide for the Use of Silica Fume in Concrete"
ACI 301	"Specification for Structural Concrete"
ACI 302.1R	"Guide for Concrete Floor and Slab Construction"
ACI 308.1M	"Specification for Curing Concrete"
ACI 308R	"Guide to Curing Concrete"
ACI 309R	"Guide for Consolidation of Concrete"

ACI 315	"Details and Detailing of Concrete Reinforcement"
ACI 315R	"Manual of Structural and Placing Drawings for Reinforced Concrete Structures"
ACI 318M	"Building Code Requirements for Structural Concrete and Commentary"
ACI-347	"Guide to Formwork for Concrete"
ACI 350M	"Code Requirements for Environmental Engineering Concrete Structures and Commentary"
ACI 350.2R	"Concrete Structures for Containment of Hazardous Materials"
ACI 350.4R	"Design Considerations for Environmental Engineering Concrete Structures"
ACI 351.1R	"Report on Grouting Between Foundations and Bases for Support of Equipment and Machinery"
ACI 360R	"Guide to Design of Slab-on-Ground"
ACI 504R	"Guide to Sealing Joints in Concrete Structures"
ACI 515.1R	"A Guide to the Use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete"
ACI 548.1R	"Guide for the Use of Polymer in Concrete"
ACI SP-66	"ACI Detailing Manual-2004"

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM A185	"Standard Specification for Steel Welded Wire Reinforcement, Plain for Concrete"
ASTM A615/A615M	"Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement"
ASTM A496/A496M	"Standard Specification for Steel Wire Deformed, for Concrete Reinforcement"
ASTM A497/A497M	"Standard Specification for Steel Welded Wire Reinforcement Deformed for Concrete"
ASTM C31/C31M	"Standard Practice for Making and Curing Concrete Test Specimens in the Field"
ASTM C33/C33M	"Standard Specification for Concrete Aggregates"
ASTM C94/C94M	"Standard Specification for Ready-Mixed Concrete"
ASTM C109/C109M	"Standard Test for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)"
ASTM C138/C138M	"Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete"
ASTM C143/C143M	"Standard Test Method for Slump of Hydraulic-Cement Concrete"

ASTM C144	"Standard Specification for Aggregate for Masonry Mortar"
ASTM C150/C150M	"Standard Specification for Portland Cement"
ASTM C171	"Standard Specification for Sheet Materials for Curing Concrete"
ASTM C172	"Standard Practice for Sampling Freshly Mixed Concrete"
ASTM C173/C173M	"Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method"
ASTM C231M	"Standard Test Method for air Content of Freshly Concrete by the Pressure Method"
ASTM C260/C260M	"Standard Specification for Air-Entraining Admixtures for Concrete"
ASTM C309	"Standard Specification form Liquid Membrane-Forming Compounds for Curing Concrete"
ASTM C404	"Standard Specification for Aggregate for Masonry Grout"
ASTM C494/C494M	"Standard Specification for Chemical Admixtures for Concrete"
ASTM C496/C496M	"Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens"
ASTM C595/C595M	"Standard Specification for Blended Hydraulic Cements"
ASTM C618	"Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete"
ASTM C920	"Standard Specification for Elastomeric Joint Sealants"
ASTM C989/C989M	"Standard Specification for Slag Cement for Use in Concrete and Mortars"
ASTM C1017/C1017M	"Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete"
ASTM C1064/C1064M	"Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete"
ASTM C1152M	"Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete"
ASTM C1202	"Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration"
ASTM C1218/C1218M	"Standard Test Method for Water-Soluble Chloride in Mortar and Concrete"
ASTM C1240	"Standard Specification for Silica Fume Used in Cementitious Mixtures"
ASTM C1580	"Standard Test Method for Water-Soluble Sulfate in Soil"
ASTM C1602/C1602M	"Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete"
ASTM D516	"Standard Test Method for Sulfate Ion in Water"

ASTM D1056	"Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber"
ASTM D1752	"Standard Specification for Performed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction"
ASTM D4130	"Standard Test Method for Sulfate Ion in Brackish Water, Sea Water, and Brines"

API (AMERICAN PETROLUM STANDARD)

API RP 686	"Recommended Practice Machinery Installation and Installation Design"
------------	---

AWS (AMERICAN WELDING SOCIETY)

AWS D1.4/D1.4M	"Structural Welding Code-Reinforcing Steel"
----------------	---

BS (BSI BRITISH STANDARDS)

BS 1881-122	"Testing Concrete, Part 122: Method for Determination of Water Absorption"
BS EN 12390-8	"Testing Hardened Concrete, Part 8: Depth of Penetration of Water under Pressure"

NIOEC- SP (NIOEC SPECIFICATIONS)

NIOEC-SP-00-10	"NIOEC Specification for Units"
NIOEC-SP-00-01	"NIOEC Specification for Civil Design Criteria"
NIOEC-SP-00-07	"NIOEC Specification for Supporting Structures and Foundations for Machinery"
NIOEC-SP-10-02	"NIOEC Specification for High Temperature Protection for Concrete"
NIOEC-SP-10-03	"NIOEC Specification for Low Temperature Protection for Concrete"

NIOEC- SD (NIOEC STANDARD DRAWINGS)

NIOEC-SD-1005-1/1	"Concrete Paving Details and Joints"
-------------------	--------------------------------------

3. UNITS

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

4. GENERAL

4.1. Contractor shall design all the concrete structures. Design shall include computations and the preparation of the engineering drawings to show the general arrangement of the members, and

all other information in the form of notes and diagrams necessary for the proper interpretation of the designer's ideas. All design and construction works should be in accordance with the ACI Standard.

The Contractor shall furnish all materials (except as noted in the Contract.), tools, equipment, utilities (except as noted), facilities scaffolding, etc., and shall perform all labor and services necessary for the proper execution and completion of all concrete work as shown on the drawings, as specified herein and/or reasonably implied there by to carry out the apparent intent of the work.

4.2. The Contractor's scope of work shall include the following items as minimum:

4.2.1. Design of all the concrete structures and preparation of all the engineering drawings.

4.2.2. Design, construction and removal of forms including scaffolding and required supports.

4.2.3. The furnishing, cutting, bending and placing of reinforcing steel and reinforcing accessories.

4.2.4. Concrete including admixtures, mixing, placing finishing, protection and curing.

4.2.5. The placing of moisture barriers, anchor bolts, sleeves. Inserts, trench angles and other embedded items detailed on the concrete drawings. Embedded items not detailed on concrete drawings such as electrical conduit, boxes, etc. will be placed under other parts of this specification.

4.2.6. Expansion and contraction joints, water stops, keyways and similar items as shown on the drawings and/or herein specified.

4.2.7. Providing suitable openings through the concrete as necessary for the proper installation, attachment and/or passing of the work of other trades.

4.2.8. Preparation of concrete surfaces for grouting and dry packing.

4.2.9. Surface preparation of concrete for protective coatings and hardeners. The Contractor will furnish hardeners.

4.2.10. One site bench mark will be furnished by Employer. Contractor shall establish the necessary lines and elevations for his own work. All stakes and marks shall be carefully preserved by the contractor for verification and use by Employer.

4.3. Item excluded from this part of specification is Masonry work.

5. MATERIALS

5.1. Test of Materials

5.1.1. The Employer shall have the right to order testing of any materials used in concrete construction to determine if materials are of quality specified.

5.1.2. Tests of materials and of concrete shall be made in accordance with standards listed in clause 3.8 of ACI 318M-11.

5.1.3. A complete record of tests of materials and of concrete shall be retained by the inspector for at least 2 years after completion of the project, and made available for inspection during the progress of the Work.

5.2. Cement

Cement shall be an approved brand of Portland cement conforming to ASTM C 150 Type I through Type V and blended hydraulic cement ASTM C595/C595M. Selection of cement type shall be according to soil investigation report, structural and durability requirements. (See ACI 225R)

Cement shall be mill tested and the mill test reports covering cement to be used in the work shall be furnished to the Employer.

Same brand of cement shall be used throughout the work to maintain uniform color and to establish undivided responsibility on liability.

5.3. Supplementary Cementitious Materials

5.3.1. Coal fly ash or natural pozzolans shall conform to ASTM C618.

5.3.2. Ground granulated blast-furnace slag shall conform to ASTM C989.

5.3.3. Silica fume shall conform to ASTM C1240.

5.4. Aggregates

Aggregates shall conform to the requirements of ASTM C33. Fine and coarse aggregates shall be regarded as separate ingredients. Each size of coarse aggregate, as well as the combination of sizes when two or more are used, shall conform to the grading requirements of the appropriate ASTM specifications.

5.5. Water

Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete or reinforcement. Water used in mixing concrete shall conform to ASTM C1602M.

Nonpotable (nondrinkable) water shall not be used in concrete unless the following are satisfied:

- a- Selection of concrete proportions shall be based on concrete mixes using water from the same source.
- b- Mortar test cubes made with nonpotable mixing water shall have 7-day and 28-day strengths equal to at least 90 percent of strengths of similar specimens made with potable water. Strength test comparison shall be made on mortars, identical except for the mixing water, prepared and tested in accordance with ASTM C109M.

5.6. Admixtures

5.6.1. Admixture is a material other than water, aggregate, or hydraulic cement, used as an ingredient of concrete and added to concrete before or during its mixing to modify its properties.

5.6.2. Admixtures to increase workability, hardness, decrease water/cement ratio, improve resistivity against chemical attack (chloride, sulfate, etc.) or other desirable characteristics may be only used if prior written approval by the Employer has been obtained.

5.6.3. Air-entraining admixtures shall conform to ASTM C260.

5.6.4. Water-reducing admixtures, retarding admixtures, accelerating admixtures; water reducing and retarding admixtures and water reducing and accelerating admixtures shall conform to ASTM C494, or ASTM C1017.

5.7. Steel Reinforcement

- 5.7.1. Deformed reinforcing steel bars shall be Grade 60 (minimum yield strength $f_y = 420\text{N/mm}^2$) in accordance with ASTM A615/A615M or alternative equivalent material upon NIOEC approval.
- 5.7.2. Plain reinforcing steel bars shall be Grade 40 (minimum yield strength $f_y = 280\text{N/mm}^2$) in accordance with ASTM A615/A615M.
- 5.7.3. Welded wire fabric and wire reinforcement, deformed shall be minimum yield strength 485N/mm^2 in accordance with ASTM A496/A496M and A497/A497M or alternative equivalent material upon NIOEC approval.
- 5.7.4. Local manufactured reinforcing steel bars and welded wire fabric with different properties than specifics in items above may be used with Employer's approval provided the design is also adjusted accordingly.

5.8. Storage of Materials

- 5.8.1. Cementitious materials and aggregates shall be stored in such manner as to prevent deterioration or intrusion of foreign matter.
- 5.8.2. Any material that has deteriorated or has been contaminated shall not be used for concrete.

6. PROPORTIONING

6.1. Selection of Concrete Proportioning

Proportions of materials for concrete shall be established to:

- Provide workability and consistency to permit concrete to be worked readily into forms and around reinforcement under conditions of placement to be employed, without segregation.
- Meet requirements of durability.
- Conform to strength test requirements. (See NIOEC-SP-00-01)

Concrete proportions shall be established in accordance with 5.3 and shall meet applicable requirements of Chapter 4 of the ACI 318M-11.

6.2. Slump

The concrete consistency as determined by the slump concrete test (ASTM C143) shall have the Table 1.

6.3. Maximum Size of Coarse Aggregate

The nominal maximum size of the aggregate shall not be larger than:

- 1/5 the narrowest dimension between sides of forms, nor;
- 1/3 the depth of slabs, nor;
- 3/4 the minimum clear spacing between individual reinforcing bars or wires, bundles of bars.