

NIOEC-SP-60-00(1)							
DOCUMENT CODE							NO. OF PAGES: 31
PLAN/PRJ/SUB	UNIT	PHASE	DISCIPLINE	DOCUMENT TYPE	SERIAL NO.	REV. NO.	DATE
NIOEC	000	EG	EL	SP	6000	A1	JUNE, 2015



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

NIOEC SP

NIOEC SPECIFICATION FOR GENERAL DESIGN PHILOSOPHY FOR ELECTRICAL SYSTEM

SECOND EDITION

JUNE, 2015

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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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REV.	DATE	PREPARED	CHECKED	APPROVED	AUTHORIZED

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1.0 SCOPE

This specification which defines NIOEC's minimum requirements for Electrical Design Criteria shall be used by Contractor.

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 IPS and the international standards, shall be made through written consent and approval of NIOEC.

1.1 The scope of this Specification is to summarize the main requirements and the general criteria shall be used for the design of the electrical system.

1.2 This Specification shall be read in conjunction with the NIOEC equipment and system specifications and the requirements of specific codes, recommendations and standards referred in item number 2.0 of this Specification.

1.3 Other Specifications shall be prepared, if required.

2.0 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.

API (AMERICAN PETROLEUM INSTITUTE)

API RP540	Electrical Installation in Petroleum Processing Plants
API 610	Centrifugal Pumps for General Refinery Service
API 617	Axial and Centrifugal Compressors and Expander-Compressors for Petroleum, Chemical and Gas Industry Services
API 661	Air-Cooled Heat Exchangers for General Refinery Services

ANSI (AMERICAN NATIONAL STANDARDS)

ANSI C 37.2	Electrical Power System Device Function Numbers and contact designation
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IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 60079	Explosive Atmospheres
IEC 60529	Degree of Protection Provided by Enclosures (IP Code)
IEC 60617	Graphical Symbols for Diagrams

IEC 61936	Power installations exceeding 1 kV a.c.
IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV)
IEC 60364	Low-voltage electrical installations
IEC 61024	Protection of structures against lightning
IEC 61312	Protection against lightning electromagnetic impulse
IEC 62305	Protection against lightning

BS (BRITISH STANDARD)

BS 7430	Code of Practice for Protective Earthing of Electrical Installation
BS 6651	Code of Practice for Protection of structures against lightning

NIOEC-SP (NIOEC SPECIFICATIONS)

NIOEC-SP-00-10	NIOEC SPECIFICATION FOR UNITS
NIOEC-SP-00-51	BASIC DESIGN PACKAGE
NIOEC-SP-47-27	NIOEC SPECIFICATION FOR FIRE FIGHTING EQUIPMENT AND FACILITIES
NIOEC-SP-60-01	SEALED TYPE POWER TRANSFORMERS
NIOEC-SP-60-02	LOW VOLTAGE INDUCTION MOTORS
NIOEC-SP-60-03	DRY TYPE POWER TRANSFORMERS
NIOEC-SP-60-04	LOW VOLTAGE SWITCHGEAR AND CONTROLGEAR
NIOEC-SP-60-05	MEDIUM AND HIGH VOLTAGE POWER CABLES
NIOEC-SP-60-06	ELECTRICAL SYSTEM INSTALLATION
NIOEC-SP-60-07	AIR CRAFT WARNING LIGHTS
NIOEC-SP-60-08	CURRENT LIMITTING REACTORS
NIOEC-SP-60-09	MEDIUM AND HIGH VOLTAGE SWITCHGEAR AND CONTROLGEAR
NIOEC-SP-60-10	CONSERVATOR TYPE POWER TRANSFORMERS
NIOEC-SP-60-11	NEUTRAL GROUNDING RESISTORS

- NIOEC-SP-60-12 POWER MANAGEMENT SYSTEM
- NIOEC-SP-60-13 DC BATTERY AND BATTERY CHARGER
- NIOEC-SP-60-14 VARIABLE SPEED DRIVES (VSD)
- NIOEC-SP-60-15 UNINTERRUPTIBLE POWER SUPPLY (UPS)
- NIOEC-SP-60-16 LOW VOLTAGE CABLES AND WIRES
- NIOEC-SP-60-17 CAPACITOR BANKS
- NIOEC-SP-60-19 ELECTRICAL HEAT TRACING
- NIOEC-SP-60-20 MEDIUM AND HIGH VOLTAGE INDUCTION MOTORS
- NIOEC-SP-60-23 TURBINE DRIVEN SYNCHRONOUS GENERATORS
- NIOEC-SP-60-24 TRANSFORMER RECTIFIER FOR IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM
- NIOEC-SP-60-25 ELECTRICAL ALARM PANEL
- NIOEC-SP-60-26 ELECTRICAL REQUIREMENTS FOR BUILDINGS
- NIOEC-SP-60-27 LOW VOLTAGE BUS DUCTS
- NIOEC-SP-60-28 SUBMARINE CABLES
- NIOEC-SP-60-31 ELECTRICAL BULK MATERIAL
- NIOEC-SP-60-34 INDUSTRIAL LIGHTING
- NIOEC-SP-60-35 LIGHTING EQUIPMENT
- NIOEC-SP-60-36 ELECTRICAL COMPONENTS OF PACKAGE UNITS
- NIOEC-SP-60-37 LIGHTING/SMALL POWER PANELS

IPS (Iranian Petroleum Standard)

IPS-E-EL-100 Electrical System Design

NFPA (National Fire Protection Association)

NFPA 780 Standard for the Installation of Lightning Protection Systems

IEEE (Institute of Electrical and Electronics Engineers)

IEEE 80	Guide for Safety in AC Substation Grounding
IEEE 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems

NEMA (The National Electrical Manufacturer's Association)**ICAO (The International Civil Aviation Organization)****3.0 UNITS**

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

4.0 ELECTRICAL DELIVERABLE LIST

The electrical required documents for the basic stage of the project shall be prepared and submitted by the contractor as per NIOEC-SP-00-51 clause 6.2.2.6 and Engineering Documents Deliverables for Detail Engineering phase (NIOEC/ED-QM/LIS-2001), shall be used.

5.0 GRAPHICAL SYMBOLS FOR ELECTRICAL DIAGRAM

- 5.1 Graphical symbols in general shall be according to the latest edition of IEC 60617.
- 5.2 When no IEC symbols are available, other symbols can be used after NIOEC approval.
- 5.3 Identification of protective relays shall be according to ANSI C.37.2.

6.0 GENERAL PHILOSOPHY**6.1 Basic Design**

- 6.1.1 The electrical system shall be economically designed for continuous and reliable services, safety to personnel and equipment, ease of maintenance and operation, minimum power losses, mechanical protection of equipment, interchangeability of equipment, and addition of future loads.
- 6.1.2 Insulation levels, interrupting capacities, current capacities, circuit protections and mechanical strengths shall be selected and coordinated in accordance with the recommendation of IEC. Necessary calculation shall be made to insure that all equipment are suitable for the duty required.

6.1.3 System protective devices such as relays, fuses, breakers, trip units, etc., shall be selected and coordinated to insure that the interrupter nearest the point of short circuit (or high overload) will open first and minimize disturbances on the rest of the system.

6.2 Environmental Criteria

Electrical installations shall be suitable for operation at continuous maximum rating under the extremes of ambient temperature and humidity imposed by the local environmental conditions, under the project environmental Specification.

All equipment and materials shall be designed for the site conditions (The external factors, e.g. altitude, air temperature, wind velocity, vibrations, earthquakes, black body temperature, relative humidity, etc., which may influence the operation of a machine or apparatus) which are installed.

7.0 POWER GENERATION SYSTEM

The electrical power generation system shall be shown on the one line diagram. Power Supply Sources will be derived from one of the following cases with due consideration to the project conditions:

- 1- Electricity import from a public utility.
- 2- On-Site generation with no public utility connection.
- 3- On-Site generation run not in parallel with a public utility.
- 4- On-Site generation run in parallel with a public utility.

Where on-site generation is selected to be the principal source of power and where a connection to a public utility is available, the public utility connection may serve:

- i) As a standby source of electric power.
- ii) A means of export of surplus electrical power.
- iii) A combination of both.

8.0 POWER DISTRIBUTION SYSTEM

8.1 The design of the distribution system shall be generally based on a dual radial system except otherwise approved by NIOEC. As the arrangement of the distribution is unique for each system, a single line diagram is required and shall govern when in conflict with this Specification.

8.2 Power shall be distributed from the power station to area substations by two incoming lines. Each incoming line shall be capable for the total plant electric demand required in normal condition at full load operation plus 20%. Normally close/open bus-ties shall be considered due to the electrical operation philosophy.

Substations and facilities such as transformers, switchgears, motor control centers, etc, shall be designed for the plant when operated at the maximum design throughput.

- 8.3** Necessary substations shall be provided and located as near as practical to the process units and offsite facilities. The loads of any process unit shall be fed from one substation only, except otherwise approved by NIOEC.

9.0 POWER MANAGEMENT SYSTEM

- 9.1** A suitable Power Management System (PMS) independent from or part of DCS/PLC with similar software and hardware to the instrument control system will be provided to allow supervision and control of the whole electrical generation and distribution systems.

- 9.2** The main purpose of PMS is an aid to operations of electrical power generation and distribution system. Failure of the PMS shall not disturb or stop operation of power generation and distribution or interlock systems. No single component failure shall result in the complete failure of PMS.

- 9.3** PMS shall interface with the Generators, High, Medium and Low Voltage switchgears, UPSs and DC Systems. Data communication with DCS for refinery operation shall also be included.

- 9.4** PMS shall be equipped with at least the following functions:

- (a) Power generator control
- (b) Electrical distribution control
- (c) Synchronizing control
- (d) Load shedding
- (e) Annunciation
- (f) Event and transient recording
- (g) Communication networks
- (h) Interfaces to other system equipment
- (j) Time synchronization

- 9.5** Visual Display Unit, Graphics Displays requirements shall be defined for Integrated Control & Safety System (ICSS) and for Electrical Control System (ECS). For ICSS the requirements shall be according to design and supply of Integrated Control and Safety System. ICSS and ECS display lists shall be prepared during Basic Engineering in accordance with the specification of Power Management System (NIOEC-SP-60-12). Typical displays shall be issued during Detailed Engineering and approved by NIOEC.

10.0 VOLTAGE LEVEL

The following voltage levels in the table shall be selected for the electrical system at rated frequency of 50HZ. Electrical equipment shall be suitable for continuous operation with voltages variation within $\pm 10\%$ of nominal values. The voltage variation of the electrical system shall not exceed $\pm 5\%$ in continuous operation.

Voltage level definition for LV, MV and HV are as per IPS-E-EL-100 as follows:

LV: $V \leq 1 \text{ KV}$
 MV: $1 \text{ KV} < V < 10 \text{ KV}$
 HV: $V \geq 10 \text{ KV}$

SERVICE	NOMINAL VOLTAGE(V)		PHASE	WIRE
Generation	Note1		3	3
Main distribution	Note1		3	3
Intermediate distribution	Note1		3	3
Emergency Power	Note1		3	3
Motors $\geq 1000 \text{ kW}$	Note2		3	3
150Kw < Motors < 1000kW	6,000		3	3
0.4Kw $\leq$ Motors < 150kW	400		3	3
Motors less than 0.4kW	230 or 400		1 or 3	2 or 3
Lighting circuit	230		1	2
Power sockets	400		3	3
	230		1	2
	24		1	2
Instrument power supply system	230		1	2
Control voltage for LV switchgear	Contactors	230 AC	1	2
	Incomers & Tie	110 DC	-	2
Control voltage for MV & HV switchgears	110 DC		-	2

Note1: To be determined during Basic Design stage.

Note2: Generally nominal voltage will be 6 KV but depends on rating and the quantity of motors, the voltage may be selected up to 11 KV.

11.0 ALLOWABLE VOLTAGE DROP

11.1 Voltage drop at terminal of electro motors shall not exceed 15% during starting period and voltage drop at terminal of electro motors shall not exceed 5% during normal operation period.

11.2 The maximum allowable voltage drops in cables, as percentage of system nominal line to line voltage, at full load shall be 5% for LV motors and 3.25% for MV and HV motors.

11.3 Voltage drop between lighting panel board and most distant fixture shall be less than 3%.

11.4 Voltage drop between 400 volt MCC and lighting panel board shall not exceed 2%.