

NIOEC-SP-60-14(1)							
DOCUMENT CODE							NO. OF PAGES: 26
PLAN/PRJ/SUB	UNIT	PHASE	DISCIPLINE	DOCUMENT TYPE	SERIAL NO.	REV. NO.	DATE
NIOEC	000	EG	EL	SP	6014	A1	DECEMBER, 2017



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

NIOEC SP

NIOEC SPECIFICATION FOR ELECTRICAL VARIABLE SPEED DRIVE SYSTEMS

SECOND EDITION

DECEMBER, 2017

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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.

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

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REV.	DATE	PREPARED	CHECKED	APPROVED	AUTHORIZED

CONTENTS:	PAGE NO.
1. SCOPE	2
2. REFERENCES.....	2
3. UNITS	3
4. GENERAL REQUIERMENT	3
4.1. Responsibility.....	3
4.2. Environmental Conditions	4
4.3. Reliability and Availability.....	4
4.4. Degree of Protection.....	5
4.5. EMC.....	5
5. DESIGN AND CONSTRUCTIONREQUIREMENTS	6
5.1. General.....	6
5.2. Electrical Supply System	6
5.3. Ratings.....	6
5.4. Transformer.....	7
5.5. Converter	8
5.6. Motor of the VSDS	12
6. PERFORMANCE REQUIREMENTS OF THE VSDS.....	12
6.1. Torque Requirements	12
6.2. Running Up Time (RT).....	13
6.3. Critical Speeds	13
6.4. Harmonics (and Inter Harmonics) at the Line Side.....	14
6.5. Pulsating Torques.....	14
6.6. Pulsating Currents	14
6.7. Efficiency.....	14
7. SYSTEM CONTROL, PROTECTION AND ALARM EQUIPMENT	15
7.1. System Control	15
7.2. Protection and Alarm Equipment	18
8. ACCESSORIES	20
9. NAMEPLATES.....	20
9.1. Identification.....	20
9.2. Rating Plate of Converter.....	21
9.3. Rating Plate of Reactor.....	21
9.4. Rating Plate of Transformer	21
10. FINISH.....	22
11. DOCUMENTATION.....	22
11.1. Within The Offer	22
11.2. Within Project Execution.....	22
12. TEST AND INSPECTION.....	23
12.1. General	23
12.2. Factory Acceptance Tests	23
12.3. Performance Tests	24
12.4. Routine Tests.....	26
12.5. String Test with Driven Equipment.....	26
13. SPARE PARTS	26
14. PACKING FOR SHIPMENT	26
15. GUARANTEE.....	26

1. SCOPE

- 1.1. This Specification covers the general requirements for design, manufacturing, and testing of the AC electrical variable speed drive system (VSDS).
- 1.2. VSDS consists of power equipment (possible harmonic filters, input transformer, converter section, possible output transformer, motor), control, protection and auxiliaries.
- 1.3. In cases where there are any other or additional requirements for the specific project, they shall be specified in other documents. This Specification gives technical requirements for the most common applications for VSDSs. For certain, applications it may be necessary to deviate from this Specification.
- 1.4. Deviations from this Specification will only be permitted on obtaining written approval from NIOEC.
- 1.5. 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.

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.

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 60034	Rotating Electrical Machines
IEC 60076	Power Transformers
IEC 60146	Semiconductor Converters
IEC 60529	Degrees of Protection Provided by Enclosures (IP Codes)
IEC 60871	Shunt Capacitors for a.c. Power Systems having a Rated Voltage above 1KV
IEC 61071	Capacitors for Power Electronics
IEC 61378	Convertor Transformers
IEC 61800	Adjustable Speed Electrical Power Drive Systems
IEC 62271	High-voltage Switchgear and Control Gear

NIOEC-SP (NIOEC SPECIFICATIONS)

NIOEC-SP-00-10	NIOEC Specification for Units
NIOEC-SP-00-11	NIOEC Specification for Site Conditions
NIOEC-SP-60-00	NIOEC Specification for General Design Philosophy for Electrical System Design
NIOEC-SP-60-02	NIOEC Specification for Low Voltage Induction Motors

NIOEC-SP-60-20

NIOEC Specification for Medium and High Voltage Induction Motors

NIOEC-SIP (NIOEC SHOP INSPECTION PROCEDURE)

NIOEC-SIP-60-00

Shop Inspection Procedure for Electrical Equipment

3. UNITS

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

4. GENERAL REQUIERMENT**4.1. Responsibility**

- 4.1.1.** The interactions between the various components of a VSDS make it imperative to make one technically acceptable manufacturer (by NIOEC) ultimately responsible for the total system.
- 4.1.2.** The order for a VSDS shall be directly placed through the manufacturer of the driven equipment. The manufacturer of the driven equipment has the responsibility for the correct operation to specification of the combination of VSDS and driven equipment.
- 4.1.3.** The manufacturer of the VSDS shall be responsible for the performance of the VSDS as described in this Specification and for compliance with the requirements of the driven equipment as given to him by the driven equipment manufacturer at the time of order.
- 4.1.4.** If deemed necessary by any of the parties involved, a pre-ordering meeting shall be arranged to define clearly the overall scope of supply, individual responsibilities and test methods.

The following shall be provided by the VSDS manufacturer:

- Calculated rotor responses;
- Ramp times;
- Transient air gap torques with their duration in the event of 2 and 3 phase short circuits at the motor terminals;
- For running up and continuous operation, data on all machine air gap torques including integer and non-integer harmonic torques in amplitude and frequency, also stating the assumptions on ratings of dc-link components;
- Lubrication requirements.

Furthermore the responsible manufacturer shall be capable of:

- Performing the necessary torsional and lateral vibration analyses;
- Performing the required studies of the total train (drive system and driven equipment) and acting as a suitable counterpart to the manufacturer of the driven equipment (and gearbox if included) to ensure good overall coordination;
- Performing the necessary electrical system studies (5.2).

The final result of these studies shall be acceptable to all parties involved.

4.2. Environmental Conditions

4.2.1. The manufacturer shall assume a background vibration severity level of 0.4 mm/s at motor bearings. If indicated in the requisition, motors shall be earthquake-proof in accordance with local requirements.

4.2.2. If a transformer forms part of the supply package then it shall preferably be located outside the substation building in a non-hazardous area according to IEC 60079-10. Reactors, harmonic filters, etc. may be installed outside the substation building in a non-hazardous area according to IEC 60079-10. The converter of the VSDS is normally located inside a substation.

4.2.3. Unless otherwise specified, the equipment to be installed indoors shall be located in a ventilated building in which the following conditions apply:

- Maximum ambient air temperature : 40 °C;
- Mean ambient temperature (over 24 h period) : 35 °C;
- Average room air temperature (conditioned) : 20 °C to 25 °C;
- Minimum ambient air temperature : 5 °C;
- Maximum relative humidity : 90 %;
- Maximum altitude : 1000 m
- Area Classification according to IEC 60079-10 : Non-hazardous

4.2.4. For equipment installed outdoors, they shall be suitable as per NIOEC-SP-00-11.

4.2.5. If water is used for cooling purposes, unless otherwise agreed the following water conditions shall be met for cooler calculation:

- Maximum inlet water temperature : 30 °C
- Average inlet water temperature over a 24 h period does not exceed : 28 °C
- Minimum inlet water temperature : 5 °C
- Maximum static water pressure : 8 bar (ga)
- Minimum static water pressure : 3 bar (ga)

Design data for coolers:

- Minimum cooling water velocity : 1 m/s
- Maximum outlet water temperature : 42 °C
- Maximum tube surface temperature : 52 °C
- Value of fouling resistance : $0.52 \times 10^{-3} \text{ m}^2 \cdot \text{K/W}$

4.2.6. The datasheet shall indicate whether a ventilation/cooling/climate conditioning facility for the converter has to be included in the supply. This shall generally be the case if the HVAC system of the room where the converter will be installed is not sufficient to provide for the heat dissipation of the converter equipment.

4.3. Reliability and Availability

4.3.1. The VSDS including all individual components forming part of the system shall have an availability of minimum 0.997 and a Mean Time Between Failure (MTBF) of at least 6 years.

- 4.3.2.** The manufacturer shall provide documented evidence that the figures quoted for MTBF and Mean Time To Repair (MTTR) can be met.
- 4.3.3.** For VSDSs that have a sufficient user base the MTBF and MTTR figures shall be based on statistics and the following criteria:
- At least one period of 6 years' operating time of at least 4 pieces of similar equipment shall have been experienced (the first 3 months of initial operation of the VSDS shall be excluded).
 - MTTR shall only relate to converter repair.
 - MTTR shall include a maintenance overhaul time of 80 h over a 2-week period after 6 years of operation.
 - Operation of the VSDS shall have been in accordance with the manufacturer's instructions.
 - Qualified men and materials shall be assumed to be available at the work site.
- 4.3.4.** For newly developed VSDSs the quoted MTBF and MTTR figures shall be based on calculations.
- 4.3.5.** The VSDS shall be designed for an expected lifetime of at least 20 years. For large VSDSs the expected lifetime of the electronic controls may be less than 20 years. The manufacturer shall state in the quotation the expected lifetime of these components. This shall not be less than 10 years.

4.4. Degree of Protection

The degree of protection, in accordance with IEC 60529 shall be at least:

- IP 54 for motor for indoor use
- IP 31 for dry type transformer and reactor for indoor use
- IP 55 for motor, transformer, reactor and auxiliaries for outdoor use
- IP 55 for the terminal boxes and bearing housings

4.5. EMC

- 4.5.1.** Electromagnetic Compatibility (EMC) shall be considered in accordance with IEC 61800-3.
- 4.5.2.** The VSDS shall be installed in an industrial area defined as 'second environment (environment that includes all establishments other than those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes)' in IEC 61800-3 and shall be category C3 or C4 depending on voltage level and rated power. For HV/MV (category C4) installations the manufacturer and NIOEC shall agree the acceptable levels.
- 4.5.3.** The NIOEC shall advise the specific EMC emission restriction of the supply network if any.
- 4.5.4.** The specific installation requirements (e.g. cabling, earthing, etc.) in order to achieve the specified emission and immunity levels shall be stated by the manufacturer.

5. DESIGN AND CONSTRUCTION REQUIREMENTS

5.1. General

- 5.1.1. VSDS shall be suitable for continuous full load service and for the operational duty of the driven equipment within the rated conditions and specified ambient conditions without exceeding the temperature rises specified in the referenced standards and without deleterious effects of any kind.
- 5.1.2. The VSDS shall be capable of withstanding the thermal and dynamic stresses and transient mechanical torques such as those resulting from a short circuit. Any damage resulting from such a short circuit or internal fault shall be confined to the component concerned to avoid damage to other parts of the VSDS.
- 5.1.3. The motor/driven equipment shall be able to withstand the transient torques developed during short circuit conditions (this shall be jointly managed with Supplier of motor/driven equipment).
- 5.1.4. The Supplier shall provide, at the bid stage, the heat generated by all indoor equipment across the full operating range of the VSDS.
- 5.1.5. The converter shall be designed based on Variable Voltage Variable Frequency (VVVF) method. The converter shall also be suitable for driving three phase motor, unless otherwise specified.

5.2. Electrical Supply System

- 5.2.1. The VSDS shall be capable of operating according to the specification under the conditions described in this clause. The nominal voltage and frequency shall be indicated in the datasheet.
- 5.2.2. VSDS shall be suitable for continuous operation with voltage variation within $\pm 10\%$ of nominal values at frequency variation of $+3\%$ and -5% .
- 5.2.3. The AC power supply at the Point of Coupling (PC) of the VSDS will be symmetrical and sinusoidal, although the input voltage may be subject to transients resulting in short term voltage drop of 80 % of nominal value, and to voltage interruptions during system short circuits. The PC of a VSDS that includes a main transformer is at the primary terminals of the transformer.
- 5.2.4. Transient high frequency voltages may also be superimposed on the input voltage as a consequence of system switching operations.
- 5.2.5. LV VSDS shall be connected to a TN-S supply system, unless otherwise specified. HV/MV VSDS shall be suitable for operation on an earthed supply system. The earthing of the supply system refers to the condition at the PC. The output of the converter may either be earthed or unearthed.
- 5.2.6. For floating supply systems, e.g. 12 pulse, the likelihood of motor earth fault currents circulating in the filter-capacitors shall be reviewed with NIOEC in the quotation stage.
- 5.2.7. The maximum and minimum prospective short circuit current at the Point of Coupling (PC) of the VSDS and Line disturbance data shall be considered by manufacturer.

5.3. Ratings

- 5.3.1. VSDS shall comply with the driven equipment characteristics as described in the datasheets. The Supplier of the VSDS shall obtain from the driven equipment Supplier all relevant data