

DEP SPECIFICATION

A.C. ELECTRICAL VARIABLE SPEED DRIVE SYSTEMS

DEP 33.66.05.33-Gen.

February 2019

DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

1.	INTRODUCTION	5
1.1	SCOPE	5
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	5
1.3	DEFINITIONS	5
1.4	CROSS-REFERENCES	7
1.5	SUMMARY OF MAIN CHANGES.....	7
1.6	COMMENTS ON THIS DEP	8
1.7	DUAL UNITS.....	8
1.8	NON NORMATIVE TEXT (COMMENTARY).....	8
2.	GENERAL REQUIREMENTS	9
2.1	SCOPE OF SUPPLY	9
2.2	STANDARDS.....	9
2.3	QUALITY ASSURANCE	10
2.4	RESPONSIBILITY	10
3.	BASIC REQUIREMENTS OF THE VSIDS	10
3.1	RELIABILITY AND AVAILABILITY	10
3.2	SERVICE CONDITIONS	11
3.3	RATINGS	12
4.	PERFORMANCE.....	12
4.1	CONTROL	12
4.2	DEVIATION BAND.....	13
4.3	RUNNING UP TIME.....	13
4.4	CRITICAL SPEEDS.....	13
4.5	ELECTROMAGNETIC COMPATIBILITY	14
4.6	PULSATING TORQUES.....	15
4.7	PULSATING CURRENTS	15
5.	CONSTRUCTION OF THE VSIDS.....	15
5.1	GENERAL.....	15
5.2	IDENTIFICATION	15
6.	CONVERTER TRANSFORMER (FOR HV VSIDS ONLY)	16
6.1	GENERAL	16
6.2	PROTECTION	16
6.3	NOISE	16
7.	REACTOR(S) (FOR HV VSIDS ONLY)	16
7.1	GENERAL	16
7.2	PROTECTION	16
7.3	NOISE	16
7.4	RATING PLATE	16
7.5	LOCATION.....	16
8.	CONVERTER	17
8.1	CONVERTER ELEMENTS.....	17
8.2	RATING OF THE CONVERTER ELEMENTS.....	17
8.3	NOISE	17
8.4	CABLING/SECONDARY WIRING.....	17
8.5	EARTHING	18
8.6	MARKING OF THE CONVERTER COMPONENTS	19
8.7	CONVERTER CABINETS	19
8.8	SYSTEM CONTROL, PROTECTION, ALARM, MONITORING, FAULT DIAGNOSTIC AND COMMUNICATION EQUIPMENT	20
8.9	RATING PLATE	22
9.	MOTOR OF THE VSIDS	22
9.1	GENERAL	22
9.2	TRANSIENT TORQUES.....	23

10.	SPARE PARTS, INSTALLATION MATERIALS AND INSTRUCTIONS.....	23
11.	ASSEMBLY AND SPECIAL TOOLS	23
12.	DOCUMENTATION	23
13.	INSPECTION AND TESTS	24
13.1	GENERAL.....	24
13.2	FACTORY ACCEPTANCE TESTS	24
13.3	PERFORMANCE TESTS	24
13.4	ROUTINE TESTS	24
13.5	STRING TEST WITH DRIVEN EQUIPMENT.....	24
13.6	PERFORMANCE TEST PROTOCOL	24
13.7	ROUTINE TEST PROTOCOL	27
14.	REFERENCES	28

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design and manufacturing of electrical Variable Speed Drive Systems (VSDSs).

This DEP can also be applied to generation units with generators operating at variable speeds and feeding into an electrical system with a constant frequency.

A VSDS comprises of the electric motor, the converter with its control and protection equipment and, where specified, the supply transformer and harmonic filters.

This DEP gives amendments and supplements to relevant IEC standards considered necessary for the VSDS to be suitable for operation and maintenance in continuously operating plants.

This is a revision of the DEP of the same number dated February 2017; see (1.5) regarding the changes.

For VSDSs designed in accordance with IEEE STD 1566, reference is made to DEP 33.66.05.32-Gen.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

The definitions as given in the IEC standards and DEPs referenced in this DEP are applicable. The following additional definitions apply:

Term	Definition
Active front end converter	Converter with input circuitry designed to limit the lineside harmonics and/or achieve regeneration.
Availability	Availability is defined as : $\frac{MTBF}{MTBF + MTTR}$
Expected lifetime of the VSDS	The expected lifetime of the VSDS is the time during which the VSDS remains suitable for the application for which it was designed, provided it is used, regularly inspected, examined and serviced in accordance with the Manufacturer/Supplier's instructions and with the replacement of lubricant etc. and of parts subject to mechanical wear and electronic component ageing.
High speed motor	A high speed motor is a motor with a speed of more than 3600 r/min within its operational speed range.
High voltage VSDS	A VSDS with its converter input voltage exceeding 1000 V (ref: IEC 61800-4).
Locked rotor torque of a VSDS motor	The average measured torque that the motor of the VSDS will develop with the rotor locked at any angular position and with the control-command set at a set-point within the operational speed range of the VSDS.
Low voltage converter	A VSDS with its converter input voltage not exceeding 1000 V (ref: IEC 61800-2).
Mean Time Between Failure (MTBF)	Total operating period divided by number of faults that have resulted in outages (hours).
Mean Time to Repair (MTTR)	Total time to repair and return to service divided by number of faults that have resulted in outages (hours).
Operational speed range of the VSDS motor	The specified range of speeds at which the VSDS motor can operate continuously at specified ratings or torques.
Operating time	Total running time elapsed after initial commissioning and start up of the VSDS at site but excluding the first 3 months of initial operation.
Point of Coupling of the VSDS (PC)	The point in the electrical network at which the VSDS is connected to that network.
Reliability	Reliability is calculated as: $e^{-\left(\frac{8760}{MTBF}\right)}$

Term	Definition
Running up time	The time for the VSDS including driven load to accelerate from standstill to the minimum operational speed at the specified line voltage and under the most arduous process conditions.
Speed Window Control	Control of the speed of the motor by the VSDS within the permitted operational range.
Total running up time of a VSDS	The time for a VSDS to complete one start up to the minimum operational speed at specified line voltage when coupled to the actual load. The total running up time is the sum of the times for the logic to start up all auxiliaries and the running up time of the VSDS.
Vibration severity	The vibration severity is the root-mean-square value of the vibration velocity.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (14).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2017. The following are the main, non-editorial changes.

Section/Clause	Change
General	Removed low-impact clauses and simplified structure. Removed requirements covered by IEC standards and other DEPs e.g.: motor and transformer DEP. Included comments from major VSDS OEMs to better align with industry standard VSDSs.
2	Scope for application of simplified requirements changed from VSDS < 250kW to LV VSDS
3.1	Requirements added for redundancy of power semiconductors and auxiliary equipment power supply.
3.2	Classification of service conditions aligned with terminology used in IEC 61800.
3.3	Maximum current from the inverter to the motor increased from 1000 A to 1250 A per phase.
4.1	Removed requirements for torque overload capability.
4.1	Simplified requirements for starting and stopping the VSDS Removed the requirement for a contactor in LV VSDS Included the use of STO to stop the VSDS.
4.5	Grouped all requirements in the scope of IEC 61800-3 e.g.; for voltage deviations, dips, restart, immunity and emission requirements for low- and high frequency in clause (4.5). Aligned requirements with IEC 61800-3.

Section/Clause	Change
8.8	Removed requirements for separate compartment for incoming supply. Included requirements for Internal Arc Classification in accordance with IEC 62477-2.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. GENERAL REQUIREMENTS

2.1 SCOPE OF SUPPLY

1. The scope of supply of the VSDS should include the following:
 - a. detailed design;
 - b. studies as indicated in this DEP and the requisition;
 - c. supply of materials;
 - d. factory and site inspection and testing;
 - e. documentation;
 - f. commissioning and start-up assistance;
 - g. spare parts for an initial 6 years operation, refer to (10);
2. Refer to requisition DEP 33.66.05.95-Gen. for HV VSDS or DEP 33.66.05.96-Gen. for LV VSDS for the following details:
 - a. Specification details of the required VSDS;
 - b. A layout diagram indicating the following:
 - i. area classification;
 - ii. the ambient conditions of the different items related to their location;
 - iii. the location of the individual equipment items;
 - iv. the cable routing.
 - c. A block diagram indicating the following:
 - i. the basic control and protection systems specifying the protection, control, trip and alarm functions to be fulfilled at the different locations;
 - ii. the reference signals and commands needed;
 - d. A single line diagram indicating the following:
 - i. main and auxiliary circuitry;
 - ii. information on fault level, system earthing and auxiliary supply systems.
 - e. Specification of cooling water where applicable.

2.2 STANDARDS

1. The VSDS shall be designed in accordance with the following IEC standards and this DEP:
 - a. IEC 61800-2;
 - b. IEC 61800-3;
 - c. IEC 61800-4;
 - d. IEC 61800-5-1;
 - e. IEC 61800-5-2;
 - f. IEC 60146.

Rationale: This DEP gives additional information and requirements, and where applicable, selects options given in the above IECs.
2. Refer to following DEPs for individual components forming part of the VSDS:
 - a. DEP 33.65.40.31-Gen. for power transformers;