

DEP SPECIFICATION

**POWER TRANSFORMERS
(AMENDMENTS/SUPPLEMENTS TO
IEC 60076-1 AND IEC 60076-11)**

DEP 33.65.40.31-Gen.

February 2017

DESIGN AND ENGINEERING PRACTICE



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These views are based on the experience acquired during involvement with the design, construction, operation and maintenance of processing units and facilities. Where deemed appropriate DEPs are based on, or reference international, regional, national and industry standards.

The objective is to set the standard for good design and engineering practice to be applied by Shell companies in oil and gas production, oil refining, gas handling, gasification, chemical processing, or any other such facility, and thereby to help achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to Shell companies for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual Operating Units to adapt the information set forth in DEPs to their own environment and requirements.

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All administrative queries should be directed to the DEP Administrator in Shell GSI.

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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for power transformers.

This DEP is based on the following parts of IEC 60076, and provides amendments and supplements to the relevant IEC standard where indicated:

- IEC 60076-1, as amended/supplemented by this DEP in (Part III);
- IEC 60076-2
- IEC 60076-3
- IEC 60076-4
- IEC 60076-5
- IEC 60076-7
- IEC 60076-8
- IEC 60076-10
- IEC 60076-11, as amended/supplemented by this DEP in (Part IV);
- IEC 60076-12

Part III of this DEP covers oil-immersed power transformers and is written as amendments/supplements to IEC 60076-1.

Part IV covers the additional requirements for dry-type transformers, and is written as amendments/supplements to IEC 60076-11. These transformers are also required to comply with the relevant parts of Part III.

Part V covers the requirements for auto-transformers.

Part VI covers the documentation requirements.

Part VII contains references.

For ease of reference, the clause (or paragraph) numbering of the relevant IEC standard has been used throughout (Part III) and (Part IV). Clauses not mentioned apply as written.

The corresponding Requisition is provided in DEP 33.65.40.93-Gen.

This DEP is a revision of the DEP of the same number, dated September 2013; see (1.5) regarding the main changes.

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 authorisation 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 **Requisition** sheet is DEP 33.65.40.93-Gen.

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

1.3.2 Specific definitions

Term	Definition
Off-Circuit tap-changer:	A device for changing the voltage ratio of the transformer only after the transformer has been isolated from the high voltage and low voltage sources.

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 (Part VII).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated September 2013. The following are the main, non-editorial changes.

Section/Clause	Change
All	Restructured and clarified requirements, enforced use of shall/should/may for normative statements.

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://swwww.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.

PART II GENERAL REQUIREMENTS

1.1 GENERAL

1. Transformers shall comply with the following parts of IEC 60076:
 - a. IEC 60076-1, as amended/supplemented by this DEP in (Part III);
 - b. IEC 60076-2
 - c. IEC 60076-3
 - d. IEC 60076-4
 - e. IEC 60076-5
 - f. IEC 60076-7
 - g. IEC 60076-8
 - h. IEC 60076-10
 - i. IEC 60076-11, as amended/supplemented by this DEP in (Part IV);
 - j. IEC 60076-12
2. (Part III) of this DEP is written as amendments and supplements to IEC 60076-1. Wherever reference is made to IEC 60076-1, it shall be understood to mean IEC 60076-1 as amended/supplemented by this DEP.
3. (Part IV) covers the additional requirements for dry-type transformers, and is written as amendments and supplements to IEC 60076-11. Wherever reference is made to IEC 60076-11, it shall be understood to mean IEC 60076-11 as amended/supplemented by this DEP. Non liquid-filled transformers shall also comply with the requirements of (Part III).
4. For ease of reference, the clause (or paragraph) numbering of the relevant IEC standard has been used throughout (Part III) and (Part IV). Clauses in the relevant IEC standard which are not mentioned in this DEP shall remain valid as written.
5. (Part V) of this DEP covers the requirements for auto-transformers, and shall be read in conjunction with (Part III) of this DEP.
6. Documentation for all transformers shall be in accordance with (Part VI).
7. The corresponding Requisition, DEP 33.65.40.93-Gen. has been extended to cover project-specific transformer requirements.

PART III REQUIREMENTS FOR OIL-IMMERSED POWER TRANSFORMERS (AMENDMENTS/SUPPLEMENTS TO IEC 60076-1)

4 SERVICE CONDITIONS

4.1 General

Add to this clause:

1. Transformers shall have a design lifetime of at least 25 years, when delivering rated output under the service conditions specified and maintained according to the Manufacturer/Supplier's recommendation.
2. Transformers shall be suitable for continuous operation at full load for at least 40,000 hours without maintenance requiring the transformer to be de-energised.
3. The transformer shall be capable of continuous operation at full load with the following system supply voltage and frequency variations:

Voltage : plus or minus 5%

Frequency : plus or minus 2%

The Requisition identifies the maximum site ambient temperature, for either outdoor or indoor transformer installations.

4. Unless otherwise specified in the Requisition, the maximum average daily temperature shall be 10 °C less than the maximum site ambient temperature:
 - a. The maximum average annual temperature shall be 20 °C less than the maximum site ambient temperature.
5. The relative humidity shall be taken to be 90% maximum.
6. The atmosphere shall be regarded as dusty, sulphurous, salty and corrosive, as commonly encountered in petrochemical installations in close proximity to the sea.

Refer to IEC 60721-3-4 and IEC 60076-11 for information on environmental conditions for equipment design and manufacture.

7. Transformers for outdoor operation shall be designed to operate without protective shelter.
8. The effect of rapid changes in ambient temperature shall also be incorporated in the design.

5 RATING and general requirements

5.1

5.1.1 General

Add to this clause:

The Requisition identifies the duty of the transformer, e.g., generator transformer.

1. All "general service" transformers shall be capable of withstanding infrequent restarting loads (e.g., motors) of up to 1.8 times the transformer's rated current for five restarts at 5-second intervals.

General service transformers may be used to feed groups of motors.

2. Motor unit transformers (e.g., transformers supplying individual motors and auto-transformers) shall be capable of withstanding three successive motor starts and a further two successive starts after a 30 minute cooling-off period (i.e., tripped).
3. When specified as a motor unit transformer on the requisition, the transformer shall be designed for a minimum of 3000 starts per year.
4. The transformer shall be capable of delivering rated current at up to 105% of rated voltage continuously.

Preferred ratings are given in (Appendix 1).

8 RATING PLATES

8.1 General

Add to this clause:

1. Rating plates shall be of stainless steel or other corrosion resistant metal.
 - a. They shall be permanently fixed to a readily accessible and non-removable part of the transformer.

8.1 INFORMATION TO BE GIVEN IN ALL CASES

Add to this clause:

1. The Principal's purchase order number shall be stated on the rating plate.

8.2 INFORMATION TO BE GIVEN IN CERTAIN CASES

Add to this clause:

1. The CT ratios shall be stated on the rating plate.

9 MISCELLANEOUS REQUIREMENTS

9.2 DIMENSIONS OF NEUTRAL CONNECTION

Add to this clause:

1. The LV neutral conductor and terminal of polyphase, general service transformers shall be located next to the phase terminals and be dimensioned to carry not less than 50% of the load of the phase conductors and terminals.

Add the following new clause:

9.6 CONSTRUCTIONAL REQUIREMENTS

9.6.1 General

1. Tanks shall be constructed of steel.
2. Oil-immersed transformers rated 1600 kVA and below shall be hermetically sealed.
3. Transformers rated above 1600 kVA and up to 3150 kVA may be either hermetically sealed or of the conservator type.
4. Hermetically sealed transformers above 3150 kVA shall be subject to the Principal's approval.
5. For sealed transformers, the space in the tank above the liquid shall be filled with either dry air or dry inert gas.
6. Transformers with conservators shall be fitted with Buchholz relays, having both alarm and trip contacts.
7. If required by the Manufacturer/Supplier, pressure relief devices shall be fitted to transformers above 1600 kVA.
 - a. Pressure relief devices shall have a trip contact and be fitted on the tank cover.

9.6.2 Windings and tappings

1. Windings shall be uniformly insulated.
2. Transformer windings rated > 5 MVA shall be copper.
3. Transformer windings rated ≤ 5 MVA may be copper or aluminium.
4. Full-power tappings shall be provided in the high voltage windings.
5. Winding connections inside transformers shall be brazed or crimped.
6. The winding arrangement shall be Dyn11, unless otherwise stated in the Requisition.
7. Transformers for VSDS and Generator step-up applications shall not be equipped with foil windings.

9.6.3 Core construction

1. For three-phase transformers, in-line, three-limb cores shall be used.

9.6.4 Core earthing

1. All metal parts of the core, frame and tank shall be maintained at earth potential.
2. The magnetic circuit of conservator type transformers exceeding 10 MVA shall be bonded to the clamping structure through only one removable core-insulation-test link or strap.
 - a. The link shall be placed in an accessible position beneath an inspection opening in the main tank cover.
 - b. With the bond removed, the magnetic circuit shall be insulated from the clamping and supporting structure and all structural parts.