

DEP SPECIFICATION

LIQUID-IMMERSED TRANSFORMERS FOR NORTH AMERICAN APPLICATION

DEP 33.65.40.32-Gen.

February 2017

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE



© 2017 Shell Group of companies

All rights reserved. No part of this document may be reproduced, stored in a retrieval system, published or transmitted, in any form or by any means, without the prior written permission of the copyright owner or Shell Global Solutions International BV.

This document contains information that is classified as EAR99 and, as a consequence, can neither be exported nor re-exported to any country which is under an embargo of the U.S. government pursuant to Part 746 of the Export Administration Regulations (15 C.F.R. Part 746) nor can be made available to any national of such country. In addition, the information in this document cannot be exported nor re-exported to an end-user or for an end-use that is prohibited by Part 744 of the Export Administration Regulations (15 C.F.R. Part 744).

This document has been supplied under license by Shell to:
UOP Honeywell ted.fuger@honeywell.com 19/01/2018 09:17:45

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of Shell Global Solutions International B.V. (Shell GSI) and, in some cases, of other Shell Companies.

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.

When Contractors or Manufacturers/Suppliers use DEPs, they shall be solely responsible for such use, including the quality of their work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will typically expect them to follow those design and engineering practices that will achieve at least the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal.

The right to obtain and to use DEPs is restricted, and is typically granted by Shell GSI (and in some cases by other Shell Companies) under a Service Agreement or a License Agreement. This right is granted primarily to Shell companies and other companies receiving technical advice and services from Shell GSI or another Shell Company. Consequently, three categories of users of DEPs can be distinguished:

- 1) Operating Units having a Service Agreement with Shell GSI or another Shell Company. The use of DEPs by these Operating Units is subject in all respects to the terms and conditions of the relevant Service Agreement.
- 2) Other parties who are authorised to use DEPs subject to appropriate contractual arrangements (whether as part of a Service Agreement or otherwise).
- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, Shell GSI disclaims any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof, even if it is wholly or partly caused by negligence on the part of Shell GSI or other Shell Company. The benefit of this disclaimer shall inure in all respects to Shell GSI and/or any Shell Company, or companies affiliated to these companies, that may issue DEPs or advise or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of Shell GSI, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of Shell GSI. The copyright of DEPs vests in Shell Group of companies. Users shall arrange for DEPs to be held in safe custody and Shell GSI may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

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

TABLE OF CONTENTS

PART I	INTRODUCTION	5
1.1	SCOPE	5
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	5
1.3	DEFINITIONS	5
1.4	CROSS-REFERENCES	6
1.5	SUMMARY OF MAIN CHANGES.....	6
1.6	COMMENTS ON THIS DEP	7
1.7	DUAL UNITS.....	7
1.8	NON NORMATIVE TEXT (COMMENTARY).....	7
PART II	GENERAL REQUIREMENTS	8
1.1	APPLICABLE STANDARDS.....	8
1.2	PAD-MOUNTED TRANSFORMERS.....	8
1.3	DOCUMENTATION REQUIREMENTS	8
1.4	NON-TECHNICAL REQUIREMENTS	8
1.5	STATEMENT OF COMPLIANCE	8
1.6	PRE-ORDERING MEETING	9
1.7	NOTIFICATION FOR TESTING	9
1.8	DATASHEET	9
PART III	REQUIREMENTS FOR LIQUID-IMMERSED POWER TRANSFORMERS (AMENDMENTS/SUPPLEMENTS TO IEEE C57.12.00).....	10
4	SERVICE CONDITIONS	10
4.3	UNUSUAL SERVICE CONDITIONS	10
5	RATING DATA	10
5.4	RATED KILOVOLTAMPERES	10
5.12	NAMEPLATE	11
6	CONSTRUCTION.....	11
6.1	BUSHINGS	11
6.2	TRANSFORMER ACCESSORIES	12
6.3	BUSHING CURRENT TRANSFORMERS.....	14
6.3	CURRENT TRANSFORMERS	14
6.5	TANK PRESSURE REQUIREMENTS	15
6.6	LIQUID INSULATING SYSTEM	15
6.7	GROUNDING.....	18
6.9	WINDINGS AND CORE	18
6.10	BUS AND CABLE CONNECTING BOXES	18
6.11	TERMINALS	20
6.12	SURGE ARRESTERS	20
6.13	AUXILIARY WIRING, CONTROL CABINETS AND AUXILIARY BOXES.....	21
6.14	TAP CHANGER FOR DE-ENERGIZED OPERATION.....	22
6.15	LOAD TAP CHANGING EQUIPMENT (LTC).....	22
6.16	MOUNTING AND HANDLING FACILITIES.....	23
6.17	LIFTING PROVISIONS FOR TRANSFORMERS TO BE APPLIED AT OFFSHORE LOCATIONS	23
6.18	COATINGS	24
6.19	SAFETY SIGNS AND LABELS	24
8	TESTING AND CALCULATIONS	25
8.1	GENERAL	25
8.2	ROUTINE, DESIGN, AND OTHER TESTS FOR TRANSFORMERS	25
8.7	CERTIFIED TEST DATA	26
9	TOLERANCES	27
9.5	CAPITALIZED LOSSES	27
PART IV	PAD-MOUNTED TRANSFORMERS	28

1.1	PAD-MOUNTED TRANSFORMERS BASIS AND APPLICATION INFORMATION.....	28
1.2	KEY INTERLOCK	28
1.3	FUSES	28
1.4	LIGHTNING ARRESTORS.....	28
1.5	DEAD-FRONT BUSHINGS	28
1.6	DOCUMENTATION REQUIREMENTS	28
PART V	DOCUMENTATION REQUIREMENTS.....	29
1.1	GENERAL	29
PART VI	SUPPLEMENTAL NON-TECHNICAL REQUIREMENTS	31
1.1	SYMBOLGY	31
1.2	CONTRACT DOCUMENTS.....	31
1.3	COMPONENTS	31
1.8	DRAWING APPROVAL	31
1.9	DATA SHEET	31
1.10	START-UP ASSISTANCE	31
1.11	SPECIAL TOOLS.....	31
1.12	QUALITY ASSURANCE AND CONTROL PROGRAM	32
1.13	SPARE PARTS.....	32
1.14	SHIPPING	33
PART VII	REFERENCES	35
 APPENDICES		
APPENDIX 1	CERTIFICATION FORM FOR OFFSHORE APPLICATIONS	36

PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design and manufacture of liquid-immersed transformers for North American application. This DEP is limited to transformers that are:

- a. three-phase;
- b. two or three winding;
- c. liquid-immersed; and
- d. air-cooled, with:
- e. a rating of 500 kVA and above
- f. up to and including voltages of 765 kV nominal for the high voltage winding.

Part III covers requirements for power transformers and is written in the form of amendments and supplements to IEEE Standard C57.12.00:2010.

Part IV covers requirements for Pad-Mounted transformers.

Part V covers documentation requirements.

Part VI covers supplemental non-technical requirements.

Part VII lists references associated with this DEP.

This is a revision of the DEP of the same number dated February 2014; see (1.5) regarding the 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.

NOTE: The Manufacturer/Supplier may also be referred to as the Vendor.

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.

NOTE: The Principal may also be referred to as the Owner or User.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

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

1.3.2 Specific definitions

Electrical terms used in this DEP are in accordance with IEEE Std C57.12.80:2010. Additional terms are defined as follows:

Term	Definition
Observed	Observed means that the Principal is notified of the timing of the inspection or test; however, the inspection or test is performed as scheduled, and if the Principal is not present, the Manufacturer then proceeds to the next step.
Witnessed	Witnessed means that a hold is applied to the production schedule and that the inspection or test is carried out with the Principal in attendance.

1.3.3 Abbreviations

Term	Definition
CSA	Canadian Standards Association
DEP	Design and Engineering Practice
NRTL	Nationally Recognized Testing Laboratory

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 is a revision of the DEP of the same number dated February 2014. The main changes are summarised below. 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 and formatting changes.

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 APPLICABLE STANDARDS**

1. Refer to (Part III) of this DEP for requirements related to transformers.
2. Refer to (Part IV) of this DEP for requirements related to pad-mounted transformers.
3. (Part III) provides amendments and supplements to IEEE Standard C57.12.00:2010.
4. This DEP is an amendment to IEEE Standard C57.12.00:2010 (hereafter IEEE C57.12.00).
5. For ease of reference, the section and clause numbering of IEEE C57.12.00 is used in (Part III) of this DEP.
6. Clauses of IEEE C57.12.00 that are not amended by this DEP shall remain applicable as written.
7. Where IEEE C57.12.00 refers to requirements "included in the standards for particular types of transformers", IEEE C57.12.10 shall be used.
8. Transformers for Canadian applications shall, in addition, comply with the standards in Table 1.

Table 1 Additional Standards for Canadian Transformers

	kVA rating (ONAN)	High Voltage kV	Standard
Distribution	225 to 2000	Up to 35	CAN/CSA C2.1
Power	Over 2000	Up to 765	CAN/CSA C88

7. Where conflicting requirements exist between the above mentioned CSA standards and the IEEE standard to which this DEP is amended, the CSA standards prevail for Canadian application.

1.2 PAD-MOUNTED TRANSFORMERS

1. Pad mounted transformers shall comply with (Part IV) of this DEP.

1.3 DOCUMENTATION REQUIREMENTS

1. Documentation shall comply with (Part V) of this DEP.

1.4 NON-TECHNICAL REQUIREMENTS

1. All transformers shall comply with the supplemental, non-technical requirements in (Part VI) of this DEP.

1.5 STATEMENT OF COMPLIANCE

1. All performance values established in the pre-ordering meeting or quotation (whichever is the later) shall be guaranteed by the manufacturer/supplier.
2. All the equipment forming part of the order shall be tested individually and in combination at the Manufacturer's facility to prove their capability and compliance with the specifications and the performance data.
3. The Manufacturer shall comply with regulatory requirements applicable to the equipment for the location in which it will be installed.

4. Whenever equipment proposed by the Manufacturer cannot fully meet the requirements of this DEP, such exceptions shall be clearly stated in Manufacturer's proposal with cross-references to the specific sections and subsections to which exceptions are taken.
 - a. Such exception shall be subject to approval of the Principal.
 - b. If no exceptions are taken to these specifications or drawings, the Manufacturer shall issue a written statement of full compliance to the DEP.
 5. If any one of the components or the whole system does not comply with the specifications and any agreed amendments, the Manufacturer shall rectify and re-test the transformer(s) within a mutually agreed time.
- 1.6 PRE-ORDERING MEETING
1. If deemed necessary by one of the parties involved, a pre-ordering meeting shall be arranged to define clearly the overall scope of supply, individual responsibilities and test methods.
- 1.7 NOTIFICATION FOR TESTING
1. The Contractor shall be notified by manufacturer/supplier ten (10) business days in advance of testing, if the testing will be executed in North America.
 2. In case the testing will be executed outside North America, the Contractor shall be notified 15 business days in advance.
- 1.8 DATASHEET
1. Data sheet DEP 33.65.40.95 Gen. shall be used to specify transformers.
 2. The applicable data sheet sections shall be completed and returned by the Manufacturer as part of the quotation.

**PART III REQUIREMENTS FOR LIQUID-IMMERSED POWER TRANSFORMERS
(AMENDMENTS/SUPPLEMENTS TO IEEE C57.12.00)****4 SERVICE CONDITIONS****4.3 UNUSUAL SERVICE CONDITIONS****4.3.3 Other unusual service conditions**

Add to this clause:

- r). The transformer, enclosures, cabling and all accessories shall be suitable for the environment as indicated on the data sheet.

Add new clauses:

4.3.4 Captive transformers

1. The design for captive transformers shall be suitable for across-the-line starting of the motor and be able to withstand the mechanical and thermal duty imposed by the magnitude of the motor starting currents and the permissible number of starts and intervals between starts.
2. Heavy-duty bracing and, if specified on the data sheet, a heavy-duty no-load tap changer, shall be provided as necessary for captive transformer service.

4.3.5 Non-linear Loads

1. Transformers specified to supply non-linear loads, such as adjustable speed drives, shall meet the requirements of IEEE C57.18.10.
2. Transformers which have more than 20% of their base rating as nonlinear loads, shall have the rating determined in accordance with IEEE C57.110.
3. The harmonic spectrum of the transformer load shall be provided by the Contractor to the transformer Manufacturer.

5 RATING DATA**5.4 RATED KILOVOLTAMPERES****5.4.2 Preferred continuous kVA ratings**

Add to this clause:

1. If forced cooling is specified on the data sheet, transformers shall have additional cooling stage ratings as per IEEE C57.12.10, Table 1.
2. ONAN/ONAF rated transformers for Canadian application shall be provided with a 1st stage cooling rating of 133%, and, if required, a 2nd stage cooling rating of 167% of the self cooled rating.

Add new clause:

5.4.3 Design life

1. Transformers shall be designed to operate continuously at rated kVA under site conditions listed on the Data Sheet.
2. Transformers shall have a design lifetime of at least 25 years, when delivering rated output under the site conditions specified, and maintained according to the Manufacturer's recommendation.

Add new clause:

5.4.4 NRTL

1. If specified, transformers shall be NRTL listed and be labelled in accordance with UL Guideline XPLH.

Guidance on NRTLs can be found at:

<http://www.osha.gov/dts/otpc/nrtl/index.html>

NRTL listing is normally not required. Examples of when a NRTL listing is required include local code authority requirements and insurance requirements.

For transformers built according to the Canadian CSA standards there is no certification available.

2. The Vendor shall provide a statement on the nameplate that the transformer is in compliance with the applicable CSA standard.

5.12 NAMEPLATE

5.12.1 General

Add to this clause:

1. Transformers shall have a stainless steel nameplate, inscribed by etching, engraving, stamping or other equally durable method, mounted with stainless steel hardware to the tank at approximately eye level

5.12.2 Nameplate information

Replace this clause with:

1. Nameplate C shall be used.
2. Nameplates for Transformers for Canadian application shall be in accordance with the applicable CSA standard and use SI units.

6 CONSTRUCTION

6.1 BUSHINGS

Add to this clause:

1. Additional bushing features include:
 - a. bushings shall have bolted construction;
 - b. gaskets shall be retained by positive means, such as recessed spaces, to avoid deformation when bushing is installed;
 - c. cork gaskets shall not be used. Provide Nitrile (Buna N), Viton or equivalent material gaskets;
 - d. for sealed transformers, the integrity of the gaskets shall be tested by pressurizing the tanks to a minimum of 10 psig for 2 hours, and checking for leaks;
 - e. for conservator type transformers, the Manufacturer shall determine the appropriate pressure test value;
 - f. bushings shall have tin-plated copper NEMA standard four-hole pads;
 - g. the neutral shall be brought out through a bushing;
 - h. to minimise spare parts, neutral bushings shall be identical to phase bushings.