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Interested committees:

Title: Draft BS IEC 61886-2 Ed.1.0 Subsea equipment. Part 2: Power transformers.

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



18/1715/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:
IEC/IEEE 61886-2 ED1

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2021-02-05

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2021-04-30

SUPERSEDES DOCUMENTS:
18/1587/NP, 18/1595A/RVN

IEC TC 18 : ELECTRICAL INSTALLATIONS OF SHIPS AND OF MOBILE AND FIXED OFFSHORE UNITS	
SECRETARIAT: Norway	SECRETARY: Mr Arild Røed
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 14	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☒ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☒ SAFETY	

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:
Subsea equipment – Part 2: Power transformers

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SUBSEA EQUIPMENT –

Part 2: Power transformers

FOREWORD

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- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC or IEEE shall not be held responsible for identifying any or all such patent rights.

This first edition of International Standard IEC 61886-2 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units, in collaboration with IEEE IAS/PCI/P1886: Subsea Electrical Applications Working Group.

This publication is published as an IEC/IEEE prefix standard and IEC/IEEE dual logo standard.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The IEC and IEEE technical committees have decided that the contents of this document will remain unchanged until the stability date indicated on the IEC and IEEE website in the data related to this publication. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The National Committees are requested to note that for this document the stability date is 20XX..

this text is included for the information of the national committees and will be deleted at the publication stage.

176

INTRODUCTION

177 Use of electrical power on the seabed is increasing. Both within the oil and gas and renewable
178 industries there is an increasing use of electrical power equipment on the seabed. Subsea
179 processing activities like compression and pumping require an increasingly higher amount of
180 electrical power. Power generation, whether onshore or offshore requires development of
181 equipment both for subsea transmission and distribution.

182 This standard includes requirements related to equipment installed below the sea surface. The
183 objective of this standard is to substitute project/client specific specifications are used both for
184 design and testing.

185 Use of this standard will avoid increased costs and schedule impact (for type testing) and
186 reduce risk for failure. By standardizing tests and implement continuous improvement on fewer
187 products, this risk will be reduced in the long term.

188 The SEPS JIP (Subsea Electrical Power Standardization Joint Industry Project) was established
189 in 2010 by seven oil and gas companies, with the aim to develop common operator standards
190 for subsea electrical power equipment and systems and support further development of these
191 into internationally recognized standards. This standard proposal is developed by SEPS. The
192 aim for the SEPS JIP is to develop IEC/IEEE dual logo standards; hence both IEC and relevant
193 ANSI/IEEE standards are referenced where applicable. Relevant equipment manufacturers
194 have contributed with review and comments to the document.

195 The lack of accessibility (for repair/replacement) defines strict requirements to reliability,
196 beyond what is normally seen in topside applications.

197 As subsea equipment in many cases is interconnected to topside equipment, specifications for
198 subsea equipment are considered to be within the TC 18 Scope.

199

SUBSEA EQUIPMENT –

Part 2: Power transformers

1 Scope

This document is applicable to three-phase and single-phase liquid immersed subsea power transformers with pre-formed windings (including auto transformers) with at least one winding with rated voltages in the range $3,6 \leq U_m \leq 145$ kV and with rated power in the range 50 kVA to 100 MVA. The intention is to specify additional requirements that are not covered by IEC 60076 series and ANSI/IEEE C57.12 series.

Subsea transformers designed and tested in accordance with this document shall fulfil both IEC 60076 and ANSI/IEEE C57.12 series with respect to performance and testing. In order to achieve this, the following philosophy has been used:

- Rated power shall be established (verified by testing) both in accordance with IEC and IEEE definitions. Only one figure (based on IEC or IEEE) shall however be on the rating plate, this shall be specified by purchaser in the contract.
- The most stringent design and test requirements are specified in this document, ensuring that both IEC and IEEE requirements are met.

For subsea transformers where no winding has a rated voltage above or equal to 3,6 kV, this standard may be applicable, either as a whole or in part.

The mechanical design principles are also applicable for liquid-immersed reactors.

The terms Transformer Assembly and Transformer Module are used in this document. Where the terms “subsea transformer” or “transformer” are used, this shall mean Transformer Assembly.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60076-1:2011: Power Transformers. Part 1: General

IEC 60076-2:2011: Power Transformers. Part 2: Temperature rise for liquid immersed transformers

IEC 60076-3: Power Transformers. Part 3: Insulation levels, dielectric tests and external clearances in air

IEC 60076-5: Power Transformers. Part 5: Ability to withstand short circuit.

IEC 60247: Insulating liquids – Measurement of relative permittivity, dielectric dissipation factor ($\tan \delta$) and DC resistivity

- 239 IEC 60296: Fluids for electrotechnical applications. Unused mineral insulating oils for
240 transformers and switchgear
- 241 IEC 60422: Mineral insulating oils in electrical equipment - Supervision and maintenance
242 guidance
- 243 IEC 61800-4: Adjustable speed electrical power drive systems - Part 4: General requirements -
244 Rating specifications for a.c. power drive systems above 1 000 V a.c. and not exceeding 35 kV
- 245 IEC 61378-1: Converter transformers-Part 1: Transformers for industrial applications
- 246 IEC/IEEE 61886-1: SUBSEA EQUIPMENT – Part 1: Power connectors, penetrators and jumper
247 assemblies with rated voltage from 3 kV ($U_{\max} = 3,6$ kV) to 30 kV ($U_{\max} = 36$ kV)
- 248 ANSI/IEEE PC57.32/DM16.3: Standard for requirements, terminology and test procedures for
249 Neutral grounding devices
- 250 ANSI/IEEE C57.12.00: General requirements for liquid-immersed distribution, power and
251 regulating transformers
- 252 ANSI/IEEE C57.12.90:2015: IEEE standard test code for liquid-immersed distribution, power
253 and regulating transformers
- 254 ANSI/IEEE C57.110-2008: IEEE Recommended Practice for Establishing Liquid-Filled and Dry-
255 Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load
256 Currents
- 257 ANSI/IEEE C57.152: IEEE Guide for Diagnostic Field Testing of Fluid-Filled Power
258 Transformers, Regulators, and Reactors
- 259 API 17F: Standard for Subsea Production Control Systems
- 260 API 17N, 2017: Subsea Production System Reliability, Technical Risk, and Integrity
261 Management, Second Edition
- 262 ASTM D971-20 : Standard Test Method for Interfacial Tension of Insulating Liquids Against
263 Water by the Ring Method
- 264 ASTM D974-14e2: Standard Test Method for Acid and Base Number by Color-Indicator Titration
- 265 ASTM D1141 - 98 (2013): Standard Practice for the Preparation of Substitute Ocean Water
- 266 ASTM D1275-15: Standard Test Method for Corrosive Sulfur in Electrical Insulating Liquids
- 267 ASTM D1298-12b, 2017: Standard Test Method for Density, Relative Density, or API Gravity of
268 Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
- 269 ASTM D1524-15: Standard Test Method for Visual Examination of Used Electrical Insulating
270 Liquids in the Field
- 271 ASTM D1533-12: Standard Test Method for Water in Insulating Liquids by Coulometric Karl
272 Fischer Titration

- 273 ASTM D1816-12, 2019: Standard Test Method for Dielectric Breakdown Voltage of Insulating
274 Liquids Using VDE Electrodes
- 275 ASTM D3487-16e1: Standard Specification for Mineral Insulating Oil Used in Electrical
276 Apparatus
- 277 ASTM D3612-02, 2017: Standard Test Method for Analysis of Gases Dissolved in Electrical
278 Insulating Oil by Gas Chromatography
- 279 ASTM D4059-00, 2018: Standard Test Method for Analysis of Polychlorinated Biphenyls in
280 Insulating Liquids by Gas Chromatography
- 281 DNV 2.7.3: Standard for certification. Portable offshore units.
- 282 EN ISO 15614-1: Specification and qualification of welding procedures for metallic materials -
283 Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and
284 nickel alloy
- 285 EN 1011: Welding — Recommendations for welding of metallic materials.
- 286 EN 10204: Metallic products — Types of inspection documents
- 287 EN ISO 21457: Petroleum, petrochemical and natural gas industries -- Materials selection and
288 corrosion control for oil and gas production systems
- 289 ISO 12103-1:2016: Road vehicles – Test contaminants for filter evaluation – Part 1: Arizona
290 Test Dust
- 291 NEMA Standards Publication ICS 61800-4-2004: Adjustable Speed Electrical Power Drive
292 Systems, Part 4: General Requirements—Rating Specifications for a.c. Power Drive Systems
293 above 1000 V a.c. and Not Exceeding 35 kV
- 294 NORSOK M-601: Welding and inspection of piping.
- 295 NORSOK M-650: Qualification of manufacturers of special materials
- 296 NORSOK M-710: Qualification of non-metallic materials and manufacturers – Polymers

297 **3 Terms, definitions and abbreviated terms**

298 For the purposes of this document, the terms and definitions of IEC 60076-1 and definitions
299 apply.

300 ISO and IEC maintain terminological databases for use in standardization at the following
301 addresses:

- 302 • IEC Electropedia: available at <http://www.electropedia.org/>
- 303 • ISO Online browsing platform: available at <http://www.iso.org/obp>

304 **3.1 Terms and definitions**

305 **3.1.1**

306 **Auxiliary chamber**

307 Chamber where components other than active parts can be installed (NGR, accessories,
308 instrumentation, controls).

3.1.2**Boost factor**

The magnetic flux margin of a variable frequency transformer core; expressed as the ratio between the flux density occurred at a low frequency (start) and the flux density at rated frequency of the transformer.

$$BF = \frac{B_{start}}{B_r} = \frac{\frac{U_{start}}{f_{start}}}{\frac{U_r}{f_r}}$$

Where

U_{start} : Start voltage based on IR-compensation

f_{start} : frequency corresponding to U_{start}

B_r : rated flux density

B_{start} : flux density at U_{start}

Note to entry: $BF=1$ is no oversizing of the core. $BF=2$ is oversizing of core cross section of 2 times $BF=1$. In a transformer with $BF=2$, the flux density is 50 % of that in a transformer with $BF=1$

3.1.3**Cable termination**

Device fitted to the end of a cable to ensure electrical connection with other parts of the system and to maintain the insulation up to the point of connection

3.1.4**Connection chamber**

Intermediate chamber between chamber for active parts and external connections.

3.1.5**Connector assembly**

Any assembly of wet and/or dry mate connectors, penetrators, cable terminations, cable pigtails or jumper cables between subsea components – or any combination of these

3.1.6**Connector**

Fully insulated termination permitting the connection and the disconnection of a cable to other equipment

3.1.7**Differential Pressure**

The difference between the two absolute values of pressure that are acting on either side of a wall or partition.

3.1.8**Dry mateable connector**

Connector designed to be submerged in sea water, but connected/disconnected in a dry (topside/onshore) environment only

3.1.9**Extended routine test**

A test to which each individual transformer is subjected once all connector assemblies have been installed.

3.1.10**IR**

Resistive voltage drop, occurring at low frequency when the inductive voltage drop is negligible

3.1.11**Penetrator**

A device that enables one or several conductors to pass through a partition such as a wall or a tank and insulates the conductors from it. The means of attachment, flange or fixing device, to the partition forms part of the penetrator. Penetrators include bulkhead mounted connector assembly components.

3.1.12**Pressure compensator**

Device fitted to a tank that ensures that the internal medium pressure is identical or close to the ambient water pressure.

Note 1 to entry: There is also a requirement to compensate for the volume expansion and contraction of the internal fluid due to temperature changes. As the pressure compensator is connected to the fluid volume, the pressure compensator must be designed to accommodate this volume expansion and contraction.

3.1.13**Rated Absolute Pressure**

Maximum absolute pressure that a subsea transformer has been designed to operate at under the specified conditions of use.

3.1.14**Rated Differential Pressure**

The maximum differential pressure that a transformer assembly has been designed to operate at under the specified conditions of use. The rated differential pressure for a transformer assembly shall be taken as the maximum pressure difference between the tank inboard side and the outboard side.

3.1.15**Routine test**

Definition used in IEC 60076-1:2011 applies.

3.1.16**Transformer Assembly**

Assembly consisting of transformer active parts, instrumentation, tank, volume (pressure) compensators and connector assemblies.

3.1.17**Transformer Module**

Complete module including (but not limited to): Transformer Assembly, handling/protection structure, shock absorbers/dampers, ROV panels etc.

3.1.18**Type test**

Definition used in IEC 60076-1 applies. For instance, increased water depth or different type of penetrators (new interfaces) implies that new type tests shall be performed. Extent of type tests on previously type tested designs is subject to agreement between manufacturer and purchaser.

3.1.19**Wet mateable connector**

Connector designed to be submerged in sea water, and can also be connected/disconnected in a submerged condition

3.2 Abbreviated terms**3.2.1****A**

Area inside the saturated winding

3.2.2**AV**

Applied Voltage Test

3.2.3**AV-R**

Applied Voltage Test – Reduced level

3.2.4**B**

Magnetic core peak flux density (Tesla)

3.2.5**BF**

Boost Factor

3.2.6**CP**

Cathodic Protection

3.2.7**h**

Electrical height of winding

3.2.8**CR**

Contact Resistance

3.2.9**HV**

High Voltage (winding)

3.2.10**IR**

Insulation Resistance

3.2.11**IVPD**

Induced Voltage test with Partial Discharge

3.2.12**IVW**

Induced Voltage Withstand test

3.2.13**K_R**

Rogowski factor