This is a free page sample. Access the full version online.



Irish Standard I.S. EN 60076-2:2011

Power transformers -- Part 2: Temperature rise for liquid-immersed transformers (IEC 60076-2:2011 (EQV))

© NSAI 2011 No copying without NSAI permission except as permitted by copyright law.

Incorporating amendments/corrigenda issued since publication:

The National Standards Authority of Ireland (NSAI) produces the following categories of formal documents:

I.S. xxx: Irish Standard – national specification based on the consensus of an expert panel and subject to public consultation.

S.R. xxx: Standard Recommendation - recommendation based on the consensus of an expert panel and subject to public consultation.

SWIFT xxx: A rapidly developed recommendatory document based on the consensus of the participants of an NSAI workshop.

<i>This document replaces:</i> EN 60076-2:1997	<i>This document is based on:</i> EN 60076-2:2011 EN 60076-2:1997	<i>Publish</i> 1 April, 28 May	2011
This document was published under the authority of the NSAI and c 8 April, 2011	omes into effect on:		ICS number: 29.180
		57 6730 57 6729 ds.ie	
Údarás um Chaighdeáin Náisiúnta na hÉireann			

EUROPEAN STANDARD

EN 60076-2

NORME EUROPÉENNE EUROPÄISCHE NORM

April 2011

ICS 29.180

Supersedes EN 60076-2:1997

English version

Power transformers -Part 2: Temperature rise for liquid-immersed transformers (IEC 60076-2:2011)

Transformateurs de puissance -Partie 2: Echauffement des transformateurs immergés dans le liquide (CEI 60076-2:2011) Leistungstransformatoren -Teil 2: Übertemperaturen für flüssigkeitsgefüllte Transformatoren (IEC 60076-2:2011)

This European Standard was approved by CENELEC on 2011-03-30. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization Comité Européen de Normalisation Electrotechnique Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

© 2011 CENELEC - All rights of exploitation in any form and by any means reserved worldwide for CENELEC members.

EN 60076-2:2011

- 2 -

Foreword

The text of document 14/669/FDIS, future edition 3 of IEC 60076-2, prepared by IEC TC 14, Power transformers, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60076-2 on 2011-03-30.

This European Standard supersedes EN 60076-2:1997.

EN 60076-2:2011 includes the following significant technical changes with respect to EN 60076-2:1997:

- the standard is applicable only to liquid immersed transformers;
- the winding hot-spot temperature rise limit was introduced among the prescriptions;
- the modalities for the temperature rise test were improved in relation to the new thermal requirements;
- five informative annexes were added in order to facilitate the standard application.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

-	latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-12-30
-	latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2014-03-30

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60076-2:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

- [2] IEC 60296:2003 NOTE Harmonized as EN 60296:2004 (not modified).
- [3] IEC 60567:2005 NOTE Harmonized as EN 60567:2005 (not modified).
- [4] IEC 60599:1999 NOTE Harmonized as EN 60599:1999 (not modified).
- [5] IEC 60836:2005 NOTE Harmonized as EN 60836:2005 (not modified).
- [6] IEC 61099:2010 NOTE Harmonized as EN 61099:2010 (not modified).

- 3 -

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	<u>EN/HD</u>	Year
IEC 60076-1 (mod)	-	Power transformers - Part 1: General	EN 60076-1	-
IEC 60076-8	1997	Power transformers - Part 8: Application guide	-	-
IEC 60085	2007	Electrical insulation - Thermal evaluation and designation	EN 60085	2008
IEC 61181	2007	Mineral oil-filled electrical equipment - Application of dissolved gas analysis (DGA) to factory tests on electrical equipment	EN 61181	2007
IEC Guide 115	2007	Application of uncertainty of measurement to conformity assessment activities in the electrotechnical sector	-	-

This page is intentionally left BLANK.

- 2 -

60076-2 © IEC:2011

CONTENTS

FOI	REWC)RD	.4
1	Scop	e	.6
2	Norm	ative references	.6
3	Term	s and definitions	.6
4	Cooli	ng methods	8
	4.1	Identification symbols	
	4.2	Transformers with alternative cooling methods	
5		nal cooling conditions	
0	5.1	Air-cooled transformers	
	5.1	Water-cooled transformers	
6	-	perature rise limits	
0	•		
	6.1 6.2	General	
	6.2	Temperature rise limits at rated power	
	0.3	Modified requirements for special cooling conditions 1 6.3.1 General	
		6.3.2 Air-cooled transformers	
		6.3.3 Water-cooled transformers	
	6.4	Temperature rise during a specified load cycle	
7		perature rise tests	
1	•		
	7.1 7.2	General1 Temperature of the cooling media1	
	1.2	7.2.1 Ambient temperature	
		7.2.1 Ambient temperature	
	7.3	Test methods for temperature rise determination	
	7.5	7.3.1 General	
		7.3.2 Test by short-circuit method for two winding transformers	
		7.3.3 Test modification for particular transformers	
	7.4	Determination of liquid temperatures	
	1.4	7.4.1 Top-liquid temperature	
		7.4.2 Bottom and average liquid temperatures	
	7.5	Determination of top, average and bottom liquid temperature rises	
	7.6	Determination of average winding temperature	
	7.7	Determination of winding resistance at the instant of shutdown	
	7.8	Determination of average winding temperature rise at the instant of	•
		shutdown	9
	7.9	Determination of the average winding to liquid temperature gradient1	9
	7.10	Determination of the hot-spot winding temperature rise	20
		7.10.1 General	20
		7.10.2 Determination by calculation	20
		7.10.3 Direct measurement during the temperature rise test	20
	7.11	Uncertainties affecting the results of the temperature rise test2	21
	7.12	Dissolved gas-in-oil analysis2	21
		Corrections	21
		(informative) Hot-spot winding temperature rise determination for OFAF and	
		poled transformers based on the top-liquid temperature in tank	
Anr	iex B	(informative) Methods to estimate the hot-spot winding temperature rises2	25

60076-2 ©	IEC:2011	- 3 -

Annex C (informative) Techniques used in temperature rise testing of liquid-immersed transformers	30
Annex D (informative) Dissolved gases analysis for the detection of local overheating	39
Annex E (informative) Application of optical fibre sensors for winding hot-spot measurements	43
Bibliography	47
Figure B.1 – Temperature rise distribution model for ON cooling methods	26
Figure B.2 – Value of factor Q as a function of rated power and strand height (W)	27
Figure B.3 – Typical liquid flow paths in a disk winding with diverting washers	28
Figure C.1 – Recommended circuit for transformers with a low resistance winding using two separate direct current sources, one for each winding	32
Figure C.2 – Alternative recommended circuit using only one direct current source for both windings	32
Figure C.3 – Average winding temperature variation after shutdown	33
Figure C.4 – Extrapolation of the cooling down curve, using the fitting curve	
$\theta_{W}(t) = A_0 - kt + Be^{-t/T_{W}} \dots$	38
Figure E.1 – Optical fibre sensor application for a disk winding of core type transformer	45
Figure E.2 – Optical fibre sensor application for a transposed cable of core type transformer	45
Figure E.3 – Modality of optical fibre sensor application in the winding spacer of core type transformer	46
Figure E.4 – Optical fibre sensor application for high voltage winding of shell type transformer	46
Table 1 – Temperature rise limits	11
Table 2 – Recommended values of temperature rise corrections in case of special service conditions	12
Table 3 – Exponents for the corrections of temperature rise test results	22
Table A.1 – Hot-spot winding temperature rises for some specific transformers determined from conventional heat run test data combined with calculated hot-spot winding temperature rise, and from direct fibre-optic measurements	
Table C.1 – Example of cooling down curve calculation spreadsheet	
Table D.1 – Minimum detectable value S_D of gases in oil	
Table D.2 – Admissible limits for gas rate increases	
Table E.1 – Minimum recommended number of sensors for three-phase transformers	
Table E.2 – Minimum recommended number of sensors for single-phase transformers	43

- 4 -

INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER TRANSFORMERS –

Part 2: Temperature rise for liquid-immersed transformers

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committee; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60076-2 has been prepared by IEC technical committee 14: Power transformers.

This third edition cancels and replaces the second edition published in 1993. It is a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the standard is applicable only to liquid immersed transformers;
- b) the winding hot-spot temperature rise limit was introduced among the prescriptions;
- c) the modalities for the temperature rise test were improved in relation to the new thermal requirements;
- d) five informative annexes were added in order to facilitate the standard application.

60076-2 © IEC:2011

- 5 -

The text of this standard is based on the following documents:

FDIS	Report on voting
14/669/FDIS	14/676/RVD

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

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

A list of all parts of the IEC 60076 series can be found, under the general title *Power transformers*, on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.



This is a free preview. Purchase the entire publication at the link below:

Product Page

S Looking for additional Standards? Visit Intertek Inform Infostore

> Learn about LexConnect, All Jurisdictions, Standards referenced in Australian legislation