

Australian/New Zealand Standard™

Power transformers

**Part 7: Loading guide for oil-immersed
power transformers
(IEC 60076-7, Ed. 1.0 (2005) MOD)**



AS/NZS 60076.7:2013

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Australian/New Zealand Standard™

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Part 7: Loading guide for oil-immersed power transformers (IEC 60076-7, Ed. 1.0 (2005) MOD)

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-008, Power Transformers, to supersede AS 2374.7—1997, *Power transformers, Part 7: Loading guide for oil-immersed power transformers*.

The objective of this Standard is to provide guidance and requirements for planners, users, purchasers and designers for the specification and loading of oil-immersed power transformers based on operating temperatures and thermal ageing, with recommendations for limitation of permissible loading according to temperature calculations and measurements.

This Standard is an adoption with national modifications and has been reproduced from IEC 60076-7, Ed. 1.0 (2005), *Power transformers, Part 7: Loading guide for oil-immersed power transformers*, and has been varied as indicated to take account of Australian/New Zealand conditions. The modifications are specified in Appendix ZZ.

Appendix ZZ addresses the following issues:

- (a) Further explanation and guidance for users is considered necessary in some Clauses [5.3(f), 8.1.4(d), 8.3.1 and 8.3.2].
- (b) Because of the high leakage flux in smaller transformers with high short circuit impedance, they need to be given the same consideration as large transformers [Clause 5.5(b)].
- (c) The calculation of temperature according to Equation 6 does not provide sufficiently accurate results for short times and therefore a more accurate equation is provided (Clause 8.2.2).

The previous edition, AS 2374.7—1997, was technically equivalent to, and reproduced from, IEC 60354, Ed. 2.0 (1991). The source text, IEC 60076-7, Ed 1.0 (2005), is a technical revision of IEC 60354, Ed. 2.0 (1991). The changes are discussed in the Introduction. The source text now includes a mathematical calculation of winding and oil time constants that was previously included as an Australian variation only.

The variations described in Appendix ZZ form the Australian and New Zealand variations for the purposes of the CB Scheme for recognition of testing to standards for safety and electrical equipment.

As this Standard is reproduced from an International Standard, the following applies:

- (i) In the source text ‘this part of IEC 60076’ should read ‘this Australian/New Zealand Standard’.
- (ii) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

<i>Reference to International Standard</i>	<i>Australian/New Zealand Standard</i>
IEC	AS/NZS
60076 Power transformers	60076 Power transformers
60076-1 Part 1: General	60076.1 Part 1: General (IEC 60076-1, Ed. 2.1 (2000) MOD)
60076-2 Part 2: Temperature rise for liquid-immersed power transformers	60076.2 Part 2: Temperature rise for liquid-immersed power transformers (IEC 60076-2, Ed. 3.0 (2011) MOD)
	AS
60076-4 Part 4: Guide to the lightning impulse and switching impulse testing—Power transformers and reactors	60076.4 Part 4: Guide to the lightning impulse and switching impulse testing—Power transformers and reactors

IEC	AS/NZS
60076-5 Part 5: Ability to withstand short-circuit	60076.5 Part 5: Ability to withstand short-circuit (IEC 60076-5, Ed. 3.0 (2006) MOD)

Only international references that have been adopted as Australian or Australian/New Zealand Standards have been listed.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the annex or appendix to which they apply. A 'normative' annex or appendix is an integral part of a Standard, whereas an 'informative' annex or appendix is only for information and guidance.

CONTENTS

1	Scope	7
2	Normative references	7
3	Definitions	7
4	Symbols and abbreviations	9
5	Effect of loading beyond nameplate rating	11
5.1	Introduction	11
5.2	General consequences	12
5.3	Effects and hazards of short-time emergency loading	12
5.4	Effects of long-time emergency loading	13
5.5	Transformer size	14
5.6	Non-thermally and thermally upgraded insulation paper	14
6	Relative ageing rate and transformer insulation life	16
6.1	General	16
6.2	Relative ageing rate	16
6.3	Loss-of-life calculation	17
6.4	Insulation life	17
7	Limitations	17
7.1	Current and temperature limitations	17
7.2	Specific limitations for distribution transformers	18
7.3	Specific limitations for medium-power transformers	19
7.4	Specific limitations for large power transformers	20
8	Determination of temperatures	21
8.1	Hot-spot temperature rise in steady state	21
8.2	Top-oil and hot-spot temperatures at varying ambient temperature and load conditions	27
8.3	Ambient temperature	32
9	Influence of tap changers	33
9.1	General	33
9.2	Short-circuit losses	34
9.3	Ratio of losses	34
9.4	Load factor	34
	Annex A (informative) Calculation of winding and oil time constant	35
	Annex B (informative) Practical example of the exponential equations method	37
	Annex C (informative) Illustration of the differential equations solution method	42
	Annex D (informative) Flowchart, based on the example in annex B	51
	Annex E (informative) Example of calculating and presenting overload data	53
	Bibliography	57

Figure 1 – Sealed tube accelerated ageing in mineral oil at 150 °C	15
Figure 2 – Thermal diagram	22
Figure 3 – Local temperature rises above air temperature in a 120 kV winding at a load factor of 1,6	23
Figure 4 – Local temperature rises above air temperature in a 410 kV winding at a load factor of 1,6	24
Figure 5 – Two fibre optic sensors installed in a spacer before the spacer was installed in the 120 kV winding.....	24
Figure 6 – Zigzag-cooled winding where the distance between all sections is the same and the flow-directing washer is installed in the space between sections	26
Figure 7 – Top view section of a rectangular winding with "collapsed cooling duct arrangement" under the yokes	26
Figure 8 – Temperature responses to step changes in the load current.....	28
Figure 9 – The function $f_2(t)$ generated by the values given in Table 5	30
Figure 10 – Block diagram representation of the differential equations.....	31
Figure 11 – Principle of losses as a function of the tap position	34
Figure B.1 – Hot-spot temperature response to step changes in the load current	40
Figure B.2 – Top-oil temperature response to step changes in the load current	40
Figure C.1 – Plotted input data for the example	47
Figure C.2 – Plotted output data for the example	50
Figure E.1 – OF large power transformers: permissible duties for normal loss of life.....	56
Table 1 – Life of paper under various conditions	15
Table 2 – Relative ageing rates due to hot-spot temperature	16
Table 3 – Normal insulation life of a well-dried, oxygen-free thermally upgraded insulation system at the reference temperature of 110 °C	17
Table 4 – Current and temperature limits applicable to loading beyond nameplate rating	18
Table 5 – Recommended thermal characteristics for exponential equations	30
Table 6 – Correction for increase in ambient temperature due to enclosure	33
Table B.1 – Load steps of the 250 MVA transformer	37
Table B.2 – Temperatures at the end of each load step	41
Table C.1 – Input data for example	46
Table C.2 – Output data for the example.....	49
Table E.1 – Example characteristics related to the loadability of transformers	53
Table E.2 – An example table with the permissible duties and corresponding daily loss of life (in "normal" days), and maximum hot-spot temperature rise during the load cycle.....	55

INTRODUCTION

This part of IEC 60076 provides guidance for the specification and loading of power transformers from the point of view of operating temperatures and thermal ageing. It provides recommendations for loading above the nameplate rating and guidance for the planner to choose appropriate rated quantities and loading conditions for new installations.

IEC 60076-2 is the basis for contractual agreements and it contains the requirements and tests relating to temperature-rise figures for oil-immersed transformers during continuous rated loading. It should be noted that IEC 60076-2 refers to the average winding temperature rise while this part of IEC 60076 refers mainly to the hot-spot temperature and the stated values are provided only for guidance.

This part of IEC 60076 gives mathematical models for judging the consequence of different loadings, with different temperatures of the cooling medium, and with transient or cyclical variation with time. The models provide for the calculation of operating temperatures in the transformer, particularly the temperature of the hottest part of the winding. This hot-spot temperature is, in turn, used for evaluation of a relative value for the rate of thermal ageing and the percentage of life consumed in a particular time period. The modelling refers to small transformers, here called distribution transformers and to power transformers.

A major change from IEC 60354:1991 is the increased use of fibre optic temperature sensors in transformers. This has radically increased the possibilities of obtaining a proper thermal modelling of power transformers, especially at step changes in the load current. These possibilities have also yielded some differences between the "oil exponent x " and the "winding exponent y " used in this part of IEC 60076 and in IEC 60076-2:1993, for power transformers:

- $x = 0,9$ in IEC 60076-2, and $x = 0,8$ in this part of IEC 60076 at ON cooling.
- $y = 1,6$ in IEC 60076-2, and $y = 1,3$ in this part of IEC 60076 at ON and OF-cooling.

For distribution transformers, the same x and y values are used in this part of IEC 60076 as in IEC 60076-2.

This part of IEC 60076 further presents recommendations for limitations of permissible loading according to the results of temperature calculations or measurements. These recommendations refer to different types of loading duty – continuous loading, normal cyclic undisturbed loading or temporary emergency loading. The recommendations refer to distribution transformers, to medium power transformers and to large power transformers.

Clauses 1 to 7 contain definitions, common background information and specific limitations for the operation of different categories of transformers.

Clause 8 contains the determination of temperatures, presents the mathematical models used to estimate the hot-spot temperature in steady state and transient conditions.

Clause 9 contains a short description of the influence of the tap position.

Application examples are given in Annexes B, C and E.

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