AS/NZS 60076.7:2013

Australian/New Zealand Standard™

Power transformers

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

STANDARDS Australia

STANDARDS NEW ZEALAND PAEREWA AOTEAROA

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Australasian Railway Association
Australian Chamber of Commerce and Industry
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Department of Resources, Energy and Tourism
Electricity Engineers Association, New Zealand
Energy Efficiency and Conservation Authority of New Zealand
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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 substituted 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:

Reference to International Standard	*Australian/New Zealand Standard*
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

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.

AUSTRALIAN/NEW ZEALAND STANDARD

Power transformers

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

1 Scope

This part of IEC 60076 is applicable to oil-immersed transformers. It describes the effect of operation under various ambient temperatures and load conditions on transformer life.

NOTE For furnace transformers, the manufacturer should be consulted in view of the peculiar loading profile.

2 Normative references

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.

IEC 60076-2:1993, *Power transformers – Part 2: Temperature rise*

IEC 60076-4:2002, *Power transformers – Part 4: Guide to the lightning impulse and switching impulse testing – Power transformers and reactors*

IEC 60076-5:2000, *Power transformers – Part 5: Ability to withstand short circuit*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
distribution transformer
power transformer with a maximum rating of 2 500 kVA three-phase or 833 kVA single-phase

3.2
medium power transformer
power transformer with a maximum rating of 100 MVA three-phase or 33,3 MVA single-phase

3.3
large power transformer
power transformer exceeding the limits specified in 3.2

3.4
cyclic loading
loading with cyclic variations (the duration of the cycle usually being 24 h) which is regarded in terms of the accumulated amount of ageing that occurs during the cycle. The cyclic loading may either be a normal loading or a long-time emergency loading