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Power transformers –
Part 20: Energy efficiency

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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POWER TRANSFORMERS –

Part 20: Energy efficiency

FOREWORD

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The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 60076-20, which is a technical specification, has been prepared by IEC technical committee 14: Power transformers.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
14/852/DTS	14/884/RVDTS

Full information on the voting for the approval of this technical specification 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 reader's attention is drawn to the fact that Annex C lists all of the “in-some-country” clauses on differing practices of a less permanent nature relating to the subject of this standard.

A list of all the parts in the IEC 60076 series, under the general title *Power transformers*, can be found 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 website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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.

INTRODUCTION

The reason prompting the preparation of this document is the need to save energy and to reduce the emission of greenhouse gases. The objective of this document is to promote a higher average level of energy performance for transformers.

It provides a basic model for national standards and, alternatively, a supplement to national standards that do not cover the whole range of transformers.

This part of IEC 60076 gives methods of specifying a transformer with an appropriate level of energy efficiency according to the loading and operating conditions applicable. It also gives minimum efficiency and maximum losses which lead to a generally acceptable balance between losses and use of other resources.

This document proposes two methods (A and B) of defining an energy efficiency index and introduces three methods of evaluating the energy performance of a transformer.

These are based on existing regional practices:

a) the Peak Efficiency Index (PEI) which should be used in conjunction with either a total cost of ownership (TCO) approach or any other mean of specifying the load factor.
b) the no-load and load losses at rated power for rationalization of transformer cores and coils for transformers generally produced in large volumes;
c) the efficiency at a defined power factor and particular load factor (typically at 50 %).

The appropriate method is chosen by agreement between purchasers and manufacturers or according to local regulations.

A transformer that does not comply with this document can still comply with the requirements of other standards in the IEC 60076 series.

Formulae for the calculation of efficiency are given to reflect different regional practices and purposes. The definition of rated power is given in IEC 60076-1.

Energy efficiency is not the sole basis for choosing a transformer. The total capital and estimated lifetime operating and maintenance costs (TCO) are also significant considerations in determining the most suitable transformer for the intended application, and may lead to the selection of more economical solutions when taking into account the lifetime of the transformers.

This document provides a standard method for evaluating the energy performance of power transformers through the use of the PEI, gives benchmark figures and the reasons why certain transformers may have efficiencies which are higher or lower than the benchmark.

Setting a reasonable value of minimum PEI will be effective in improving the overall energy performance of the installed transformer population by eliminating transformers with low efficiency, with the exception for some specific network limitations.

The use of a minimum value of PEI sets a floor for transformer energy performance, but the use of TCO evaluation for purchasing transformers is essential to select a transformer with the optimal economically justified level of efficiency.

POWER TRANSFORMERS –

Part 20: Energy efficiency

1 Scope

This part of IEC 60076 is applicable to transformers in the scope of IEC 60076-1.

The energy performance levels given in Clause 6 are not applicable to the following transformers:

- transformers for high current rectifiers as described in the IEC 61378 (all parts) and in the IEC 60146 (all parts);
- transformers for furnace applications;
- transformers for offshore applications;

NOTE 1 Transformer to be installed on fixed or floating offshore platforms, offshore wind turbines or on board of ships and all kind of vessels).

- transformers for emergency or temporary mobile installations;

NOTE 2 Transformers designed only to provide cover for a specific time limited situation when the normal power supply is interrupted either due to an unplanned occurrence such as failure or a station refurbishment, but not to permanently upgrade an existing substation.

- traction transformers;
- earthing transformers as described in 3.1.10 of IEC 60076-6:2007.
- phase shifting transformers;
- instrument transformers (IEC 61869-1);
- transformers and auto-transformers specifically designed for railway feeding systems, as defined in EN 50329;
- traction catenary supply transformer for 16,67 Hz;
- transformer for high current rectifiers (IEC 61869-1);

NOTE 3 These are transformers specifically designed and intended to supply power electronic or rectifier loads specified according to IEC 61378-1.

NOTE 4 This exclusion does not apply to transformers intended to provide AC power from DC sources such as transformers for wind turbine and photo voltaic applications as well as transformers designed for DC transmission and distribution applications."

- transformers for railway feeding systems (EN 50329);
- subsea transformers;
- starting-, testing- and welding transformers;
- starting transformers, specifically designed for starting three-phase induction motors so as to eliminate supply voltage dips;

NOTE 5 Examples are transformers that are de-energised during normal operation, used for the purpose of starting a rotating machine).

- transformers specifically designed for explosion-proof and underground mining applications;
- transformers which cannot fulfil the energy performance requirements due to unavoidable size and weight limitations.

NOTE 6 Due to the unavoidable weight and size limitation for a rolling stock application, this definition includes all traction transformers for rolling stock, irrespective of the frequency (e.g. 16,7 Hz, 25 Hz, 50 Hz, 60 Hz).

In this document, "transformers" includes both separate winding transformers and autotransformers.

NOTE 7 Transformers intended to provide AC power from DC sources such as transformers for wind turbine and photo voltaic applications as well as transformers designed for DC transmission and distribution applications are included in the Scope of this document.

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, *Power transformers – Part 1: General*

IEC 60076-2, *Power transformers – Part 2: Temperature rise for liquid-immersed transformers*