IEEE Std C57.12.00™-2006
(Revision of
IEEE Std C57.12.00-1999)

IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

Sponsor

Transformers Committee

of the

IEEE Power Engineering Society

Approved 15 September 2006

IEEE-SA Standards Board

Abstract: Electrical, mechanical, and safety requirements are set forth for liquid-immersed distribution and power transformers, and autotransformers and regulating transformers; single and polyphase, with voltages of 601 V or higher in the highest voltage winding. This standard is a basis for the establishment of performance, limited electrical and mechanical interchangeability, and safety requirements of equipment described; and for assistance in the proper selection of such equipment. The requirements in this standard apply to all liquid-immersed distribution, power, and regulating transformers except the following: instrument transformers, step-voltage and induction voltage regulators, arc furnace transformers, rectifier transformers, specialty transformers, grounding transformers, mobile transformers, and mine transformers.

Keywords: autotransformers, distribution transformers, electrical requirements, mechanical requirements, power transformers, regulating transformers, safety requirements

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Print: ISBN 0-7381-5251-X SH95585
PDF: ISBN 0-7381-5252-8 SS95585

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

Use of an IEEE Standard is wholly voluntary. The IEEE disclaims liability for any personal injury, property or other damage, of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this, or any other IEEE Standard document.
The IEEE does not warrant or represent the accuracy or content of the material contained herein, and expressly disclaims any express or implied warranty, including any implied warranty of merchantability or fitness for a specific purpose, or that the use of the material contained herein is free from patent infringement. IEEE Standards documents are supplied "**AS IS**."

The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation. When a document is more than five years old and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

In publishing and making this document available, the IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity. Nor is the IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing this, and any other IEEE Standards document, should rely upon the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854
USA

Introduction

This introduction is not part of IEEE Std C57.12.00-2006, IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

This standard is a voluntary consensus standard. Its use may become mandatory only when required by a duly constituted legal authority, or when specified in a contractual agreement. To meet specialized needs and to allow for innovation, specific changes are permissible when mutually determined by the user and the manufacturer, provided these changes do not violate existing laws and are considered technically adequate for the function intended.

When this standard is used on a mandatory basis, the words *shall* and *must* indicate mandatory requirements. The words *should* and *may* refer to matters that are recommended or permissive, but not mandatory.

When applicable, editorial changes have been incorporated into this revision. Sentence structure and punctuation has been edited to improve clarity and conciseness. Also, editorial changes have been made to conform to the *IEEE Standards Style Manual*. Some changes have also been made to correct errors in previous revisions.

When applicable, references to other standards have been updated.

Changes of major importance to the revision of this standard are listed in sequential order and reference by their clause number or table number:

In Clause 2, the designation and title for IEEE Std C57.131™-1995 has been corrected. IEEE Std C62.1™-1989 (Reaff 1994) and IEEE Std C62.2™-1987 (Reaff 1994) have been removed. Also, ANSI C92.2-1987 has been added.[a]

In 4.3.3, item g) has been revised to read: "Unusual duty or frequency of operation, or high current short duration loading."

In 5.1, the word "power" has been replaced with "kVA" in the paragraph preceding the examples.

In 5.10.3.1, IEEE Std C62.11™-1999 [B40] has been added as surge arrester information.[b]

In Table 2, row 5 has been revised from ONAN/ODAF to ONAN/OFAF, and previous designation is revised to OA/FOA without reference to footnote a).

In 5.4.2, the entire second paragraph has been removed after a lengthy debate by the PCS working group. The position of the working group is that this information belongs in product-specific standards and not in standard for general requirements.

In 5.5.3, words referring to the capacity of taps for windings with load tap-changing equipment have been revised.

In Table 5, 250 kV BIL (corresponding to 69 kV nominal system voltage) has been added.

In 9.11.1, the determination of maximum (hottest spot) temperature rise by calculation or testing was added. Prior editions of this standard required the hottest spot temperature rise not to exceed 80 °C. However, there was no approved test or calculation method for this required performance parameter. Many transformer users rely on this parameter for loading calculations. Therefore, an IEEE task force was

[a] Additional information on references can be found in Clause 2.

[b] Numbers in brackets refer to sources in the bibliography found in Annex A.

formed to propose a revision of 5.11.1.1. Fiber optic temperature sensors now permit direct measurement of specific points. Prior winding analysis permits sensor placement for reading maximum winding temperature. Also, modern computer technology permits heat transfer programs to calculate the temperature distribution within transformer windings. At the time this revision was approved, an IEEE working group had developed IEEE Std 1538™ [B15], IEEE Guide for Determination of Maximum Winding Temperature Rise in Liquid Filled Transformer. This guide provides additional guidance for compliance with 5.11.1.1.

Subclause 5.12 of this standard recognizes the use of metric and/or empirical units for data appearing on transformer nameplates. In this revision of IEEE Std C57.12.00, all units of dimension, volume, weight, and pressure are listed in metric and empirical (U.S. customary) units. Subclause 5.12.1 has been modified to accommodate either system of units for nameplate information. Numerous equations throughout this standard have also been revised to reflect the use of metric and empirical units.

In 5.12.1, the requirement for an LTC nameplate per IEEE Std C57.131 has been added.

In Table 10, dual system of units for weight or mass has been incorporated. Additional text preceding the table was added to clarify the intent of allowing either SI system of units (metric) or the U.S. customary units (in, lbs) on the nameplate, but does not require both. Additional editorial changes have been made to the entire table for greater clarity. The requirement for "location (country)" has been added to "name of manufacturer".

Also in Table 10, changes have been made to the table notes. The changes are as follows:

- Note 1, the minimum height requirement for engraved letters and numerals (denoting kVA, serial number, and voltage ratings) has been changed to 4.00 mm (0.157 in).
- Note 9, the following statement has been added: "Any nonlinear devices, capacitors, or resistors installed on the winding assembly or on any tap changer shall be indicated on the nameplate."
- Note 11 (b) has been amended to include the statement: "The manufacturer shall identify any portion of the transformer that cannot withstand the stated vacuum level (i.e., conservator, LTC boards, radiators, etc.)."

Table 11(a) and Table 11(b) have been renumbered to Table 11 and Table 12 respectively.

Table number 15 has been assigned to the existing table on category of transformer rating (previously without a table number). Subsequent table numbers have been updated in sequential order. All references to table numbers in the text of the document have also been updated.

In 6.6, a reference to "Askarel" has been removed and replaced with references to "less flammable hydrocarbon fluid" and "silicone fluid".

Table 20, (Base current calculation factors), previously Table 18, has been modified with new cooling class designations.

Throughout the document, equation numbers have been assigned to be consistent with latest *IEEE Standards Style Manual.*

In 7.4, Equation (7) through Equation (11) have been updated to correct previous errors.

In 8.2, the previous title, "Routine and other tests for transformers" has been revised to "Routine, design, and other tests for transformers."

Subclause 8.5 (Determination of thermal duplicate temperature-rise data) has been added to replace a note in Table 21 and to clarify specifically when the design test may be omitted.

Subclause 8.6 has been added to address the requirements of the certified test report. The text came verbatim from Clause 15 of existing IEEE Std C57.12.90™-1999. Clause 15 will be removed from the next revision of IEEE Std C57.12.90 that coincides with this revision.

An area not considered or covered in this revision is a clause requiring an "Instruction manual" including criteria for minimum information content. This will be developed by a working group in a future revision.

Revisions of individual sections (now modified) were prepared by separate groups within the Transformers Committee. Those sections were balloted independently according to applicable rules and procedures of the IEEE for the preparation and approval of voluntary consensus standards. This process was approved by the IEEE Transformers Committee, the IEEE-SA Standards Board, and the Accredited Standards Committee for Distribution and Power Transformers and Regulators (C57). Applicable rules and procedures; specifically procedures for voting, review, and attempted reconciliation of dissenting viewpoints; a 60-day public review period; and final review and approval by the ANSI Board of Standards Review, were followed.

Suggestions for improvement resulting from use of this standard will be welcomed.

Notice to users

Errata

Errata, if any, for this and all other standards can be accessed at the following URL: http://standards.ieee.org/reading/ieee/updates/errata/index.html. Users are encouraged to check this URL for errata periodically.

Interpretations

Current interpretations can be accessed at the following URL: http://standards.ieee.org/reading/ieee/interp/index.html.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The IEEE shall not be responsible for identifying patents or patent applications for which a license may be required to implement an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Participants

At the time this standard was completed, the Continuous Revision of C57.12.00 Working Group had the following membership:

Bill Chiu, *Co-Chair*

Dong S. Kim, *Co-Chair*

Stephen Antosz	Donald Platts	Subhash Tuli
Mark Perkins	Steven Snyder	Loren Wagenaar

Other individuals who contributed review and comments are as follows:

Subhash Tuli, *Chair, 2001–2005*

At the time this standard was completed, the Performance Characteristic Subcommittee Revision of PC57.12.00 Working Group has the following membership:

Steven Snyder, *Chair*

Stephen Antosz	Robert Grunert	Timothy Raymond
Javier Arteaga	Robert Hartgrove	Ewald Schweiger
Donald Ayers	Roger Hayes	Hemchandra Shertukde
Ron Barker	Richard Hollingsworth	H. Jin Sim
John Borst	Rowland James, Jr.	Pritpal Singh
Craig Colopy	Sheldon Kennedy	Thomas Spitzer
Jerry Corkran	John Lackey	Craig Stiegemeier
John Crouse	Dennis Marlow	Ed Tenyenhuis
Alan Darwin	Susan McNelly	Robert Thompson
RonaldDaubert	Ray Nicholas	Subhash Tuli
Donald Fallon	Bipin Patel	Loren Wagenaar
Ramsis Girgis	Mark Perkins	Peter Zhao
Bill Griesacker	Donald [illegible]	Waldemar Ziomek
Myron Gruber	Jeewan Puri	

At the time this standard was completed, the Insulation Life Subcommittee had the following membership:

Donald Platts, *Chair*

David Aho	Don Duckett	Dennis Marlow
Stephen Antosz	Fred Elliott	John Matthews
Javier Arteaga	Donald Fallon	Phillip McClure
Donald Ayers	Joseph Foldi	Susan McNelly
Ron Barker	Michael Franchek	Charles Patrick McShane
David Barnard	James Gardner	Van Nhi Nguyen
Thomas Basse[illegible]	Ali Ghafourian	Bipin Patel
Barry [illegible]aster	Bill Griesacker	Mark Perkins
[illegible]inder	Myron Gruber	Paulette Powell
[illegible]ettger	Jack Hammers	Gustav Preininger
[illegible]	Robert Hartgrove	Thomas Prevost
[illegible] Chiu	Peter Heinzig	Jeewan Puri
Donald Chu	Thang Hochanh	Timothy Raymond
Jerry Corkran	Philip Hopkinson	Ewald Schweiger
John Crouse	Virendra Jhonsa	Devki Sharma
Ronald Daubert	Joseph Kelly	Ibrahim Shteyh
Eric Davis	Michael Lau	H. Jin Sim
Dieter Dohnal	Richard Marek	Steven Snyder

Craig Stiegemeier
Ronald Stoner
Thomas Traub
Subhash Tuli
Robert Veitch
Loren Wagenaar
David Wallach
Felipe Weffer
Robert Whearty
Alan Wilks

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

Samuel Aguirre
Paul Ahrens
Stephen Antosz
Jim Antweiler
Donald Ayers
Martin Baur
Barry Beaster
Stephen Beckman
Oscar Bello
W. J. (Bill) Bergman
Edward Bertolini
Gene Blackburn
William Boettger
John Borst
Jeffrey Britton
Steven Brown
Carl Bush
Max Cambre
Donald Cash
Craig Colopy
Tommy Cooper
Jerry Corkran
John Crouse
Guru Dutt Dhingra
Alan Darwin
Dieter Dohnal
Randall Dotson
Don Duckett
Donald Dunn
Fred Elliott
Keith Ellis
Gary Engmann
Jorge Fernandez-Daher
Donald Fallon
Bruce Forsyth
Marcel Fortin
Dudley Galloway
Eduardo Garcia
George Gela
Harry Gianakouros
David Gilmer
Andersen Green
Randall Groves
Myron Gruber
Michael Jardin
Roger Hayes
Ernst Hanique
Kenneth Hanus
James Harlow
Robert Hartgrove
George Henry
Edward Horgan, Jr.
Michael Horning
James D. Huddleston, III
Timothy Huff
James Rowland
Marion Jaroszewski
Lars-Erik Juhlin
C. J. Kalra
Gael Kennedy
Sheldon Kennedy
Neil Kranich
John Lackey
Stephen R. Lambert
Mike Lau
Boyd Leuenberger
Stan Lindgren
Maurice Linker
Lisardo Lourido
Donald Lowe
Thomas Lunquist
Gregory Luri
Joseph Ma
Al Maguire
Richard Marek
J. Dennis Marlow
John Matthews
Thomas McCaffrey
Ken McClenahan
Phillip McClure
Susan McNelly
Nigel Mcquin
Jose Carlos Mendes
Samuel Michael
Gary Michel
Kent Miller
Dan Mulkey
Arthur Neubauer
Ray Nicholas
Jesse Patton
Paulette Payne
Carlos Peixoto
Gustav Preininger
Gerald Paiva
Bipin Patel
Sanjay Patel
Thomas Pekarek
Mark Perkins
Linden Pierce
Paul Pillitteri
Robert Plaster
Donald Platts
Bertrand Poulin
Thomas Prevost
Jeff Ray
Charles Rayburn
Radhakrishna Rebbapragada
Johannes Rickmann
Pierre Riffon
John Rossetti
James Ruggieri
Vallamknoda Sankar
Jordan Shikoski
Tom Short
Stephen Shull
H. Jin Sim
Chuck Simmons
Harinderpal Singh
Ed Smith
James Smith
Jerry Smith
Steven Snyder
Craig Stiegemeier
Ronald Stoner
John Sullivan
Ed Tenyenhuis
Malcolm Thaden
Shanmugan Thamilarasan
Jim Thompson
Thomas Traub
Alan Traut
Subhash Tuli
Joseph Vaschak
Loren Wagenaar
Barry Ward
Joe Watson
Chris Wickersham
Alan Wilks
James Wilson
William Wimmer
Waldemar Ziomek

When the IEEE-SA Standards Board approved this application guide on 15 September 2006, it had the following membership:

Steve M. Mills, *Chair*
Richard H. Hulett, *Vice Chair*
Judith Gorman, *Secretary*

Mark D. Bowman
Dennis B. Brophy
Joseph Bruder
Richard Cox
Bob Davis
Julian Forster*
Joanna N. Guenin
Mark S. Halpin
Raymond Hapeman
William B. Hopf
Lowell G. Johnson
Herman Koch
Joseph L. Koepfinger*
David J. Law
Daleep C. Mohla
Paul Nikolich
T. W. Olsen
Glenn Parsons
Ronald C. Petersen
Gary S. Robinson
Frank Stone
Malcolm V. Thaden
Richard L. Townsend
Joe D. Watson
Howard L. Wolfman

*Member Emeritus

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

Satish K. Aggarwal, *NRC Representative*
Richard DeBlasio, DOE Representative
Alan H. Cookson, NIST Representative

Contents

IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

1. Overview

1.1 Scope

This standard is a basis for the establishment of performance, limited electrical and mechanical interchangeability, and safety requirements of equipment described. It is also a basis for assistance in the proper selection of such equipment.

This standard describes electrical, mechanical, and safety requirements of liquid-immersed distribution and power transformers, and autotransformers and regulating transformers, single-phase and polyphase, with voltages of 601 V or higher in the highest voltage winding.

This standard applies to all liquid-immersed distribution, power, and regulating transformers that do not belong to the following types of apparatus:

a) Instrument transformers

b) Step voltage and induction voltage regulators

c) Arc furnace transformers

d) Rectifier transformers

e) Specialty transformers

f) Grounding transformers

g) Mobile transformers

h) Mine transformers

1.2 Word usage

When this standard is used on a mandatory basis, the words *shall* and *must* indicate mandatory requirements. The words *should* and *may* refer to matters that are recommended or permissive, but not mandatory. The introduction of this voluntary consensus standard describes the circumstances under which the standard *may* be used on a mandatory basis.