

IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid- Cast and/or Resin-Encapsulated Windings

Sponsor

**Transformers Committee
of the
IEEE Power Engineering Society**

Approved 16 September 1998

IEEE-SA Standards Board

Abstract: Electrical, mechanical, and safety requirements of ventilated, nonventilated, and sealed dry-type distribution and power transformers or autotransformers, single and polyphase, with a voltage of 601 V or higher in the highest voltage winding, are described. Information that can be used as a basis for the establishment of performance, interchangeability, and safety requirements of equipment described, and for assistance in the proper selection of such equipment, is given.

Keywords: autotransformer connection, basic lightning impulse insulation level (BIL), dielectric strength, distribution transformer, nonventilated dry-type transformer, power transformer, resin encapsulated, short circuit, single-phase, solid cast, temperature rise, three phase, ventilated dry-type transformer, winding

The Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street, New York, NY 10017-2394, USA

Copyright © 1998 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 31 December 1998. Printed in the United States of America.

Print: ISBN 0-7381-1451-0 SH94692
PDF: ISSN 0-7381-1452-9 SS94692

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. Members of the committees serve voluntarily and without compensation. They are not necessarily members of the Institute. The standards developed within IEEE represent a consensus of the broad expertise on the subject within the Institute as well as those activities outside of IEEE that have expressed an interest in participating in the development of the standard.

Use of an IEEE Standard is wholly voluntary. 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.

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.

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 all 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.

Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
USA

Note: 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 for which a license may be required by an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Authorization to photocopy portions of any individual standard for internal or personal use is granted by the Institute of Electrical and Electronics Engineers, Inc., provided that the appropriate fee is paid to Copyright Clearance Center. To arrange for payment of licensing fee, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; (978) 750-8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Introduction

(This introduction is not part of IEEE Std C57.12.01-1998, IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings.)

This standard, together with its companion standards documents, represents a new milestone in standards for dry-type transformers, which are becoming increasingly more important with the elimination of askarel insulating fluids in new transformers.

This standard is the result of an effort encompassing the interests of users, manufacturers, and others dedicated to producing voluntary consensus standards primarily for dry-type transformers.

This revision was developed to recognize dry-type transformers with solid-cast and resin-encapsulated windings. The Working Group that developed the revision identified requirements for IEEE Std C57.12.01-1989, incorporating dry-type transformers with solid-cast and resin-encapsulated windings in 3.1 through 5.10, 5.12, and 6.52 of this standard. In addition, new materials and coil design techniques necessitated a revision that recognizes factors that differ from conventional design of dry-type transformers.

Previous editions of this standard used a constant 30 °C difference between hottest-spot and average winding temperature rises for a kVA range from 1–20 000 kVA. Since the last revision of this standard, a Working Group reviewed hottest-spot and average temperature-rise data. Several manufacturers of different transformer designs conducted extensive test programs. The Working Group concluded that the difference between the hottest-spot and average temperature rise was dependent on the size and design of the transformer. For some large transformer designs the difference may exceed 30 °C, however, for small units, the difference is considerably below 30 °C. The Working Group recommended a constant ratio of hottest-spot to average winding temperature rise for the various insulation temperature classes. This approach improves harmonization with international standards such as IEC 60050-726:1982. The revision of this standard clarifies the requirement that hottest-spot temperature rise is a performance criteria to be met by the manufacturer. Calculation of hottest-spot temperature rise is required by this revision; however, future study is planned to develop test procedures to verify hottest-spot temperature rise.

This revision was developed by the Working Group of the Dry-Type Transformers Subcommittee of the IEEE Transformer Committee of the IEEE Power Engineering Society.

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 relationship. To meet specialized needs and to allow innovation, specified changes are permissible when mutually determined by the user and the producer, provided such changes do not violate existing laws and are considered technically adequate for the function intended.

Participants

The Accredited Standards Committee on Transformers, Regulators, and Reactors, C57, which reviewed and approved this standard, had the following personnel at the time of approval:

J. W. Matthews, Chair

B. K. Patel, Vice Chair

T. A. Prevost, Standards Coordinator

H. J. Sim, Secretary

<i>Organization Represented</i>	<i>Name of Representative</i>
American National Standards Institute	C. Zegers
Electric Light and Power Group	W. Cole
	G. Gunnella
	P. E. Orehek
	D. Soffrin (<i>Alt.</i>)
	J. Sullivan
	A. Velazquez
Institute of Electrical and Electronics Engineers	J. J. Bergeron
	J. D. Borst
	J. Davis
	L. Savio
	R. A. Veitch
National Electrical Manufacturers Association	G. D. Coulter
	P. Dewever (<i>Alt.</i>)
	J. D. Douglas
	P. J. Hopkinson (<i>Alt.</i>)
	W. C. Kendall
	K. R. Linaley
	L. S. McCormick
	J. R. Miller
	R. P. Miller, Sr.
	J. J. Nay (<i>Alt.</i>)
	H. Robin
	H. D. Smith (<i>Alt.</i>)

The following is a list of participants in the Working Group of the Dry-Type Transformers Subcommittee:

Anthony J. Jonnatti, Chair

Stephen Antosz	Mike Iman	Linden W. Pierce
Kal Atout	Charles W. Johnson, Jr.	Gry Pregent
Roy A. Bancroft	Sheldon P. Kennedy	Richard L. Provost
David Barnard	Alexander D. Kline	Jeewan L. Puri
Max A. Cambre	Timothy Lewis	Dilip Purpoht
Jerome Frank	Don Macmillan	Subas Sarkar
Michael E. Haas	Richard P. Marek	Michael Schacker
N. Wayne Hansen	Michael I. Mitelman	Wes Schwartz
Roger Hayes	W. E. Morehart	Patrick Scully
Timothy L. Holdway	Randy Mulligan	Tony Siebert
Philip J. Hopkinson	William H. Mutschler, Jr.	R. William Simpson, Jr.
Rush Horton	Claude Paradis	John C. Sullivan
Edward W. Hutter	Wesley F. Patterson, Jr.	Vis Thenappan

The following members of the balloting committee voted on this standard:

George Allen	Alexander D. Kline	Donald W. Platts
Stephen Antosz	Egon Koenig	Tom A. Prevost
J. Arteaga	Joseph L. Koepfinger	Richard L. Provost
Donald Ballard	Alvin Kopp	Jeewan L. Puri
Roy A. Bancroft	John G. Lackey	D. R. Purohit
David Barnard	J. P. Lazar	David N. Reynolds
Mike Barnes	Timothy Lewis	John R. Rossetti
A. Bartek	Albert Livshitz	Hazairin Samaulah
W. J. Bill Bergman	Donald L. Lowe	Leo J. Savio
Wallace B. Binder	William A. Maguire	William E. Saxon
Max A. Cambre	Charles Mandeville	Michael Schacker
Jerry L. Carkran	Richard P. Marek	Patrick Scully
Don Chu	John W. Matthews	Vic Shenoy
Robert C. Degeneff	L. Bruce McClung	Mark Siehling
Dieter Dohnal	Jack W. McGill	Hyeong Jin Sim
Randall L. Dotson	Nigel P. McQuin	R. William Simpson, Jr.
Richard F. Dudley	C. Patrick McShane	Tarkeshwar Singh
Gary R. Engmann	Sam Michael	James E. Smith
Saurabh Ghosh	Daleep C. Mohla	Ronald J. Stahara
Richard D. Graham	Chuck R. Murray	Ron W. Stoner
Michael E. Haas	R. J. Musil	John C. Sullivan
N. Wayne Hansen	William H. Mutschler, Jr.	Malcolm V. Thaden
Timothy L. Holdway	Carl G. Niemann	James A. Thompson
Philip J. Hopkinson	T. V. Oommen	Subhash C. Tuli
T. Huff	Gerald A. Paiva	John Vandermaar
John S. Hurst	B. K. Patel	Joseph J. Vaschak
Edward W. Hutter	Paulette A. Payne	Robert A. Veitch
Robert W. Ingham	Carlos Peixoto	Loren B. Wagenaar
Virendra Jhonsa	Mark D. Perkins	Robert Whearty
Charles W. Johnson, Jr.	Linden W. Pierce	Roger Wicks
Anthony J. Jonnatti		William G. Wimmer

When the IEEE-SA Standards Board approved this standard on 16 September 1998, it had the following membership:

Richard J. Holleman, *Chair*

Donald N. Heirman, *Vice Chair*

Judith Gorman, *Secretary*

Satish K. Aggarwal	James H. Gurney	L. Bruce McClung
Clyde R. Camp	Jim D. Isaak	Louis-François Pau
James T. Carlo	Lowell G. Johnson	Ronald C. Petersen
Gary R. Engmann	Robert Kennelly	Gerald H. Peterson
Harold E. Epstein	E. G. "Al" Kiener	John B. Posey
Jay Forster*	Joseph L. Koepfinger*	Gary S. Robinson
Thomas F. Garrity	Stephen R. Lambert	Hans E. Weinrich
Ruben D. Garzon	Jim Logothetis	Donald W. Zipse
	Donald C. Loughry	

*Member Emeritus

Yvette Ho Sang
IEEE Standards Project Editor

Contents

1.	Scope.....	1
2.	References.....	2
3.	Definitions.....	3
4.	Service conditions.....	3
	4.1 Usual service conditions	3
	4.2 Unusual service conditions	4
5.	Rating data	7
	5.1 Cooling classes of transformers.....	7
	5.2 Frequency.....	7
	5.3 Phases.....	7
	5.4 Rated kVA	7
	5.5 Voltage ratings and taps.....	7
	5.6 Connections.....	8
	5.7 Polarity, angular displacement, and terminal markings.....	9
	5.8 Impedance	10
	5.9 Losses.....	10
	5.10 Insulation levels	10
	5.11 Temperature rise and insulation-system capability.....	14
	5.12 Nameplates.....	18
6.	Construction.....	21
	6.1 Tank-pressure requirements.....	21
	6.2 Finish	21
	6.3 Transformer accessories.....	21
	6.4 Terminals	21
	6.5 Grounding	24
7.	Short-circuit characteristics	24
	7.1 General.....	24
	7.2 Transformer categories	24
	7.3 Short-circuit-current duration and magnitude.....	25
	7.4 System zero-sequence data	28
	7.5 Application conditions requiring special consideration.....	28
	7.6 Components	28
	7.7 Base kVA and base currents	28
	7.8 Effects of temperature on transformer windings during short-circuit conditions.....	29
	7.9 Temperature limits of transformer for short-circuit conditions	29
	7.10 Calculation of winding temperature during a short circuit.....	29

8.	Testing and calculations.....	31
8.1	General.....	31
8.2	Test classifications	31
8.3	Routine, design, and other tests for transformers	31
8.4	Calculations.....	31
9.	Tolerances	33
9.1	Ratio.....	33
9.2	Impedance.....	33
9.3	Losses.....	33
10.	Connection of transformers for shipment	34
Annex A (informative)	Unusual temperature and altitude	35

IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings

1. Scope

This standard is intended as a basis for the establishment of performance, interchangeability, and safety requirements of equipment described, and for assistance in the proper selection of such equipment.

Electrical, mechanical, and safety requirements of ventilated, nonventilated, and sealed dry-type distribution and power transformers or autotransformers (single and polyphase, with a voltage of 601 V or higher in the highest voltage winding) are described.

The information in this standard applies to all dry-type transformers except as follows:

- a) Instrument transformers;
- b) Step- and induction-voltage regulators;
- c) Arc-furnace transformers;
- d) Rectifier transformers;
- e) Specialty transformers;
- f) Mine transformers.

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

NOTE—The introduction of this voluntary consensus standard describes the circumstances under which the standard may be used on a mandatory basis.

2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

ANSI/ASME, Boiler and Pressure Vessel Code (BPV) 1995, Section VIII, Division 1—Pressure Vessels, or Division 2—Alternative Rules.¹

ANSI C57.12.50-1981 (Reaff 1989), American National Standard Requirements for Ventilated Dry-Type Distribution Transformers, 1 to 500 kVA, Single-Phase, and 15 to 500 kVA, Three-Phase with High-Voltage 601 to 34 500 Volts, Low-Voltage 120 to 600 Volts.

ANSI C57.12.51-1981 (Reaff 1989), American National Standard Requirements for Ventilated Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase with High-Voltage 601 to 34 500 Volts, Low-Voltage 208Y/120 to 4160 Volts.

ANSI C57.12.52-1981 (Reaff 1989), American National Standard Requirements for Sealed Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase with High-Voltage 601 to 34 500 Volts, Low-Voltage 208Y/120 to 4160 Volts.

ANSI C57.12.55-1987, American National Standard Dry-Type Transformers in Unit Installations, Including Unit Substations—Conformance Standard.

ANSI C57.12.57-1986, American National Standard Requirements for Ventilated Dry-Type Network Transformers 2500 kVA and Below, Three-Phase, High-Voltage 34 500 Volts and Below, Low-Voltage 216Y/125 and 480Y/277 Volts.

ANSI C57.12.70-1978 (Reaff 1993), American National Standard Terminal Markings and Connections for Distribution and Power Transformers.

ANSI C84.1-1995, American National Standard Voltage Ratings for Electric Power Systems and Equipment (60 Hz).

IEEE Std 99-1980 (Reaff 1992), IEEE Recommended Practice for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electric Equipment.²

IEEE Std 100-1996, IEEE Standard Dictionary of Electrical and Electronics Terms.

IEEE Std 315-1975 (Reaff 1993), IEEE Graphic Symbols for Electrical and Electronics Diagrams. (DoD)

IEEE Std C57.12.00-1993, IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

IEEE Std C57.12.56-1986 (Reaff 1993), IEEE Standard Test Procedure for Thermal Evaluation of Insulation Systems for Ventilated Dry-Type Power and Distribution Transformers.

IEEE Std C57.12.60-1998, IEEE Guide for Test Procedures for Thermal Evaluation of Insulation Systems for Solid-Cast and Resin-Encapsulated Power and Distribution Transformers.

¹ANSI and ANSI/ASME publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

²IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://www.standards.ieee.org/>).

IEEE Std C57.12.80-1978 (Reaff 1992), IEEE Standard Terminology for Power and Distribution Transformers.

IEEE Std C57.12.91-1995, IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.

IEEE Std C57.94-1982 (Reaff 1987), IEEE Recommended Practice for the Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers.

IEEE Std C57.96-1989, IEEE Guide for Loading Dry-Type Distribution and Power Transformers.

IEEE Std C57.98-1993, IEEE Guide for Transformer Impulse Tests.

IEEE Std C57.124-1991 (Reaff 1996), IEEE Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers.

IEEE Std C62.2-1987 (Reaff 1994), IEEE Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems.

3. Definitions

Standard transformer terminology, available in IEEE Std C57.12.80-1978, shall apply. Other electrical terms are defined in IEEE Std 100-1996.

4. Service conditions

4.1 Usual service conditions

4.1.1 General

Transformers conforming to this standard shall be suitable for operation at rated kVA under the usual service conditions in 4.1.2 through 4.1.9.

4.1.2 Temperature

The temperature of the cooling air (ambient temperature) shall not exceed 40 °C, and the average temperature of the cooling air for any 24 hour period shall not exceed 30 °C.

The minimum ambient temperature shall not be lower than –30 °C.

4.1.3 Altitude

The altitude shall not exceed 1000 m (3300 ft).

4.1.4 Supply voltage

The supply-voltage wave shape shall be approximately sinusoidal, and the phase voltage supplying a polyphase transformer shall be approximately equal in magnitude and of approximate equal time phase in displacement.

4.1.5 Load current

The load current shall be approximately sinusoidal. The harmonic factor shall not exceed 0.05 per unit.

NOTE—*Harmonic factor* is defined in IEEE Std C57.12.80-1978.³

4.1.6 Operation above rated voltage

Transformers shall be capable of

- a) Delivering rated output in kVA at 5% above rated secondary voltage, without exceeding the limiting temperature rise, when the power factor of the load is 80% or higher;
- b) Operating at 10% above rated secondary voltage at no load without exceeding the limiting temperature rise;
- c) Fulfilling the foregoing requirements for rated voltage, rated frequency, and rated kVA for any tap.

The maximum continuous transformer operating voltage should not exceed the levels specified in ANSI C84.1-1995.

NOTE—System conditions may require voltage transformation ratios involving tap voltages higher than the maximum system voltage for regulation purposes. However the appropriate maximum system voltage should be observed under operating conditions.

4.1.7 Location

Sealed and nonventilated transformers shall be suitable for indoors, outdoors, or indoor and outdoor operation as specified.

Unless otherwise specified, ventilated transformers shall be suitable for indoor operation only.

4.1.8 Step-down operation

Unless otherwise specified, dry-type transformers shall be designed for step-down operation.

NOTE—See also Note 9 of Table 11.

4.1.9 Tank or enclosure finish

Temperature limits and tests shall be based on the use of a nonmetallic pigment-coating finish.

4.2 Unusual service conditions

4.2.1 General

Conditions, other than those described in 4.1, are considered unusual service conditions and, when present, should be brought to the attention of those responsible for the design and application of the apparatus.

³Information on references can be found in Clause 2.

4.2.2 Unusual loading

IEEE Std C57.96-1989 provides guidance for loading under unusual conditions, including

- a) Ambient temperatures higher or lower than the basis of rating;
- b) Short-time loading in excess of nameplate kVA with normal life expectancy;
- c) Loading that results in reduced life expectancy.

NOTE—IEEE Std C57.96-1989 is a guide. It provides the best known general information for the loading of transformers under various conditions based on typical winding insulation systems, and it is based upon the best engineering information available at the time of preparation. The guide discusses limitations of ancillary components other than windings that may limit the capability of transformers to meet the guide. When specified, construction features (cables, leads, tap changers, etc.) shall be supplied so that the ancillary components will not in themselves limit the short-time loading to less than that which will result in no loss in normal life expectancy of the winding insulation system. This guide does not cover solid-cast and/or resin-encapsulated windings.

4.2.3 Unusual altitude service conditions

Annex A provides guidance concerning operation above 1000 m (3300 ft), including the effects of altitude on temperature rise, operation at rated kVA and reduced ambient temperature, and operation at less than rated kVA.

4.2.4 Insulation at high altitude

The dielectric strength of transformers that depend in whole or in part upon air for insulation decreases as the altitude increases due to the effect of decreased air density. When specified, transformers shall be designed with larger air spacing, using the correction factors from Table 1 to obtain adequate air dielectric strength at altitudes above 1000 m (3300 ft).

The insulation level at 1000 m (3300 ft) multiplied by the correction factor from Table 1 shall be not less than the required insulation level at the required altitude.

4.2.5 Other unusual service conditions

- a) Damaging fumes or vapors, excessive or abrasive dust, explosive mixtures of dust or gases, steam, salt spray, and excessive moisture or dripping water constitute service conditions for which some dry-type transformers are not intended and, therefore, may have detrimental effects on transformer life;

NOTE—The seriousness of the effects of the unusual conditions listed in item a) varies widely, depending upon the design of dry-type transformer involved. While such conditions may have little or no effect on sealed, solid-cast and/or resin-encapsulated or nonventilated dry-type transformers, they may have serious effects on ventilated dry-type transformers.

- b) Abnormal vibrations, tilting, shock, or seismic conditions;
- c) Ambient temperatures outside the normal range;
- d) Unusual transportation or storage conditions;
- e) Unusual space limitations;
- f) Unusual maintenance problems;
- g) Unusual duty or frequency of operation, impact loading;
- h) Unbalanced ac voltages, or departure of ac system voltages from a sinusoidal waveform, as identified in 4.1.4;

- i) Loads involving abnormal harmonic currents, such as those that may result where solid-state or similar devices control appreciable load currents. Harmonic currents may cause excessive losses and abnormal heating. Limits for usual service conditions are identified in 4.1.5;
- j) Multiwinding transformers with a specified combination of kVA outputs and power factors for each winding;
- k) Unusually high, low, or unbalanced ac system impedance;
- l) Overexcitation exceeding 110% rated V/Hz;
- m) Planned short circuits as part of a regular operating or relaying practice;
- n) Short-circuit application conditions requiring special consideration as described in 7.5;
- o) Special insulation requirements or unusual transient voltages present on the ac power supply, including resonant or switching-related disturbances;
- p) Unusually strong magnetic radiation;
- q) Unusually high nuclear fields;
- r) Parallel operation.

NOTE—While parallel operation is not unusual, it is desirable that users advise manufacturers if paralleling with other transformers is planned and identify the transformers involved.

Table 1—Dielectric strength correction factors for altitudes greater than 1000 m (3300 ft)

Altitude		Altitude correction factor for dielectric strength
(m)	(ft)	
1 000	3 300	1.00
1 200	4 000	0.98
1 500	5 000	0.95
1 800	6 000	0.92
2 100	7 000	0.89
2 400	8 000	0.86
2 700	9 000	0.83
3 000	10 000	0.80
3 600	12 000	0.75
4 200	14 000	0.70
4 500	15 000	0.67
NOTE—An altitude of 4 500 m (15 000 ft) is considered a maximum for transformers conforming to this standard.		