

Recognized as an American National Standard (ANSI) IEEE C57.12.58™-1991 (R2008)

IEEE Guide for Conducting a Transient Voltage Analysis of a Dry-Type Transformer Coil

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

Approved 27 June 1991
Reaffirmed 25 September 2008
IEEE Standards Board

Approved 11 October 1991
Reaffirmed 6 February 1997
American National Standards Institute

Abstract: General recommendations for measuring voltage transients in dry-type distribution and power transformers are provided. Recurrent surge voltage generator circuitry, instrumentation, test sample, test point location, mounting the test coil, conducting the test, and reporting results are covered.

The Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street, New York, NY 10017-2394, USA
Copyright © 1991 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 1991. Printed in the United States of America
ISBN 1-55937-158-7

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 Technical Committees of the IEEE Societies and the Standards Coordinating Committees of the IEEE 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 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 technical 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 Standards Board
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
USA

IEEE Standards documents are adopted by the Institute of Electrical and Electronics Engineers without regard to whether their adoption may involve patents on articles, materials, or processes. Such adoption does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the standards documents.

Foreword

(This Foreword is not a part of IEEE C57.12.58-1991, IEEE Guide for Conducting a Transient Voltage Analysis of a Dry-Type Transformer Coil.)

This guide covers general recommendations for measuring voltage transients in dry-type distribution and power transformers.

Insulation is recognized as one of the most important constructional elements of a transformer. Its chief function is to confine the current to useful paths, preventing its flow into harmful channels. Any weakness of insulation may result in the failure of the transformer. Dielectric strength is a measure of the effectiveness with which insulation performs. It was once accepted that low-frequency tests alone were adequate to demonstrate the dielectric strength of transformers. As more became known about lightning phenomena, and as impulse-testing apparatus was developed, it became apparent that the distribution of impulse voltage stress through the transformer winding varies with the configuration of the windings.

Impulse voltages are distributed initially on the basis of winding capacitances. If this initial distribution differs from the final low-frequency inductance distribution, the impulse energy will oscillate between the two distributions until the energy is dissipated and the inductance distribution is reached. In severe cases, these internal oscillations can produce voltages to ground that approach twice the applied voltage. Along with the variation in size of transformer windings and the physical configuration of the windings, the impulse voltage distribution when chopping the applied wave was considered by the task force that developed this guide. Since there was insufficient information on how to interpret the short-time oscillations on the insulation system, the inclusion of the chopped wave was deferred until a later date.

The Dry-Type Dielectric Working Group was formed by the Transformers Committee of the IEEE Power Engineering Society to determine standard methods for examining the impulse voltage distribution within dry-type transformer windings; to establish a means for defining the location and magnitude of maximum voltage stress in a dry-type transformer coil; and to support other committee activities, such as the Thermal Evaluation Working Group (C57.12.56).

At the time that this standard was completed, the Dry-Type Dielectric Working Group had the following membership:

A D. Kline, *Chair*

B. F. Allen
R. Bancroft
D. A. Barnard
A. Bimbiris
M. Cambre
O. R. Compton
J. Frank
R. E. Gearhart
R. Hayes

R. H. Hollister
J. W. Hupp
A. M. Iverson
A. J. Jonnatti
S. P. Kennedy
E. Loenig
M. L. Manning
R. A. Marek

M. I. Mitelman
J. J. Nay
W. F. Paterson
R. I. Provost
J. Rodden
V. Thenappan
R. E. Uptegraff, Jr.
G. H. Vaillancourt
H. J. Windisch

At the time that it balloted and approved this standard for submission to the IEEE Standards Board, the Transformers Committee of the IEEE Power Engineering Society had the following membership:

E. J. Adolphson
L. C. Aicher*
D. J. Allan
B. Allen
R. Allustiarti
M. S. Altman

J. C. Arnold
J. Aubin
R. Bancroft
D. Barnard
D. L. Basel
P. L. Bellaschi*

S. Bennon*
W. B. Binder
J. V. Bonucchi
J. D. Borst
C. V. Brown
O. R. Compton

F. W. Cook
 J. L. Corkran
 D. W. Crofts
 J. N. Davis
 D. H. Douglas
 R. F. Dudley
 J. C. Dutton*
 J. K. Easley*
 J. A. Ebert
 F. E. Elliott
 D. J. Fallon
 H. G. Fischer
 S. L. Foster*
 M. Frydman
 H. E. Gabel*
 R. E. Gearhart
 D. W. Gerlach
 D. A. Gillies
 R. S. Girgis
 R. L. Grubb
 F. J. Gryszkiewicz
 G. Hall
 J. H. Harlow
 F. W. Heinrichs
 W. R. Henning
 K. R. Highton
 P. J. Hoefler
 C. Hoesel
 R. H. Hollister
 C. C. Honey*
 E. Howells
 Y. P. Iijima
 G. W. Iliff*
 D. C. Johnson*

D. L. Johnson
 A. J. Jonnatti
 C. P. Kappeler
 R. B. Kaufman*
 J. J. Kelly
 W. N. Kennedy
 J. P. Kinney
 A. D. Kline
 E. Koenig
 J. G. Lackey
 R. E. Lee
 H. F. Light
 L. W. Long*
 L. A. Lowdermilk
 R. I. Lowe
 H. B. Margolis*
 T. Massouda
 J. W. Matthews
 J. McGill
 C. J. McMillen
 W. J. McNutt
 S. P. Mehta
 C. K. Miller
 C. H. Millian
 R. E. Minkwitz
 M. Mitelman
 H. R. Moore
 R. J. Musil
 W. H. Mutschler
 E. T. Norton
 R. A. Olsson*
 P. E. Orehek
 B. K. Patel
 W. F. Patterson

H. A. Pearce
 D. Perco
 L. W. Pierce
 J. M. Pollitt
 C. P. Raymond
 C. A. Robbins
 W. P. Sampat
 L. J. Savio
 W. E. Saxon
 D. N. Sharma
 V. Shenoy
 L. R. Smith
 W. W. Stein
 L. R. Stensland
 F. Stevens
 D. Sundin
 L. A. Swenson
 D. S. Takach
 A. L. Tanton
 V. Thenappan
 R. C. Thomas*
 J. A. Thompson
 T. P. Traub
 D. E. Truax
 W. B. Uhl
 R. E. Uptegraff, Jr.
 G. H. Vaillancourt
 R. A. Veitch
 L. B. Wagenaar
 R. J. Whearty
 A. L. Wilks
 J. G. Wood
 W. E. Wrenn
 A. C. Wurdack*

*Member Emeritus

The Accredited Standards Committee on Transformers, Regulators, and Reactors, C57, that reviewed and approved this document, had the following members at the time of approval:

Leo J. Savio, *Chair*
John A. Gauthier, *Secretary*

<i>Organization Represented</i>	<i>Name of Representative</i>
Electric Light and Power Group	P. E. Orehek S. M. A. Rizvi F. Stevens J. Sullivan J. C. Thompson M. C. Mingoia (<i>Alt.</i>)
Institute of Electrical and Electronics Engineers	J. D. Borst J. Davis J. H. Harlow L. Savio H. D. Smith R. A. Veitch

National Electrical Manufacturers Association	G. D. Coulter P. Dewever J. D. Douglas A. A. Ghafourian K. R. Linsley R. L. Plaster H. Robin R. E. Uptegraff, Jr. P. J. Hopkinson (<i>Alt.</i>) J. Nay (<i>Alt.</i>)
Tennessee Valley Authority.....	F. A. Lewis
Underwriters Laboratories, Inc.	W. T. O'Grady
US Department of Agriculture, REA	J. Bohlk
US Department of Energy, Western Area Power Administration	D. R. Torgerson
US Department of the Interior, Bureau of Reclamation.....	F. W. Cook, Sr.
US Department of the Navy, Civil Engineering Corps	H. P. Stickley

When the IEEE Standards Board approved this standard on June 27, 1991, it had the following membership:

Marco W. Migliaro, *Chair*
Donald C. Loughry, *Vice Chair*
Andrew G. Salem, *Secretary*

Dennis Bodson
Paul L. Borrill
Clyde Camp
James M. Daly
Donald C. Fleckenstein
Jay Forster*
David F. Franklin
Ingrid Fromm

Thomas L. Hannan
Donald N. Heirman
Kenneth D. Hendrix
John W. Horch
Ben C. Johnson
Ivor N. Knight
Joseph L. Koepfinger*
Irving Kolodny
Michael A. Lawler

John E. May, Jr.
Lawrence V. McCall
Donald T. Michael*
Stig L. Nilsson
John L. Rankine
Ronald H. Reimer
Gary S. Robinson
Terrance R. Whittemore

*Member Emeritus

Adam Sicker
IEEE Standards Project Editor

CLAUSE	PAGE
1. General	1
1.1 Functional Diagram.....	1
1.2 Recurrent Surge Generator.....	1
1.3 Voltage Measurement	2
2. Recurrent Surge Voltage Generator Circuitry	2
2.1 Description of the Circuit.....	2
2.2 Selection of Element Values	3
3. Instrumentation	6
3.1 General	6
3.2 Frequency Response	6
3.3 Common-Mode Rejection	7
3.4 Grounding Practice	8
4. Test Sample.....	9
4.1 Sample Description	9
4.2 Description of Transient Phenomena	9
4.3 Test Leads	9
5. Test Point Locations.....	9
5.1 General	9
5.2 Pancake-Type (Disc-Type) Coils.....	9
5.3 Layer-Wound Coils.....	10
5.4 End Turns.....	11
5.5 Additional Test Points.....	11
6. Mounting the Test Coil	12
7. Conducting the Test	12
7.1 Test Coil.....	12
7.2 Surge Generator	12
7.3 Voltage Measurements.....	12
8. Reporting Results	13
9. Bibliography.....	13
Annex A (informative) Solution of Decay Rate of Surge Generator.....	14

IEEE Guide for Conducting a Transient Voltage Analysis of a Dry-Type Transformer Coil

1. General

1.1 Functional Diagram

Since the function of transient analysis is to determine the response of various parts of the coil to an impulse wave, the circuitry and instrumentation must be designed with that goal in mind. From a functional point of view, the relationship between the test specimen, circuitry, and instrumentation may be seen best in the form of a block diagram, as shown in Fig 1.

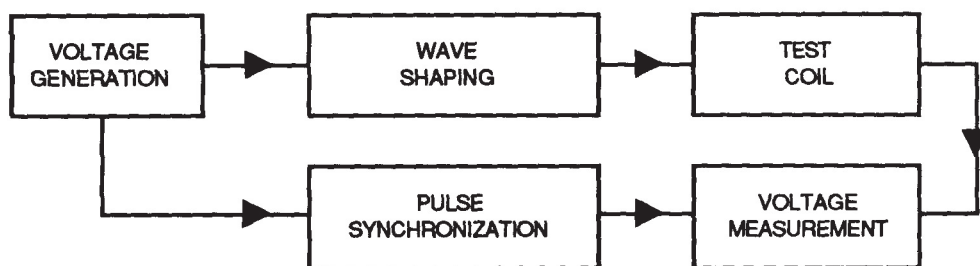


Figure 1— Block Diagram of Transient Analysis System

1.2 Recurrent Surge Generator

The voltage-generation and wave-shaping functions are performed by a device called a recurrent surge generator. This generator must duplicate, at some voltage compatible with low-voltage instrumentation, the wave shapes seen at the output of an impulse generator. The surge generator, since it is operating at a low voltage, may generate the wave on a recurrent basis. In fact, observation of voltages on an oscilloscope face will be facilitated if the voltage wave is recurrent.