

An American National Standard

IEEE Guide for Reporting Failure Data for Power Transformers and Shunt Reactors on Electric Utility Power Systems

Sponsor

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IEEE Power Engineering Society**

Secretariat

**Institute of Electrical and Electronics Engineers
of the
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Foreword

(This Foreword is not a part of ANSI/IEEE C57.117-1986, IEEE Guide for Reporting Failure Data for Power Transformers and Shunt Reactors on Electric Utility Power Systems.)

The IEEE Transformer Reliability Working Group was formed in 1974 under the Performance Characteristics Subcommittee of the IEEE Transformers Committee. The purpose of this working group was to investigate the feasibility of pursuing transformer reliability on electric utility power systems. To best address the subject of transformer reliability, the IEEE Working Group concentrated on this guide.

Early in the development of this guide, it was recognized that the Edison Electric Institute (EEI), and in particular, the Electrical System and Equipment Committee (ES&E Committee), had an existing data collection system for summarizing equipment outages, and in particular, one category devoted to power transformers. An effort was made to develop this guide in such a manner that common goals between IEEE and EEI could be established. It was the intent that by working together, both groups could develop a single, flexible dynamic system that would benefit the whole transformer industry, both user and manufacturer alike.

The EEI data base summarizes installations and failures for power transformers 2.5 MVA and above. Although the principles proposed in this guide can be used for any homogeneous population, it is anticipated that initial efforts using the principles of this guide will be directed toward large MVA transformers installed on electric utility power systems.

The thrust of this guide is to define reliability terms and to establish guidelines for a data base and reporting mechanism for power transformer failures. In developing this guide it was discovered that the subject of failure analysis could support a document of its own. Accordingly, a separate working group has been formed and assigned a project to perform this task.

The Accredited Standards Committee C57 had the following membership when it reviewed and approved this document:

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H. F. Light, Chair

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J. C. Dutton	J.G. Lackey	R.J. Whearty
C. G. Evans	C. Lindsay	
C.M. Gardam	R.I. Lowe	

In order to pursue its goals, the Working Group Chairman established a task force to produce various sections of this guide. The membership of the task force included:

D. J. Cash	J.W. Grimes	H.F. Light
J. E. Dind*	R.P. Johnston	R.J. Whearty
C. M. Gardam	J.G. Lackey	

*It is with deep regret that during the writing of this guide, we lost one of our members, J. E. Dind. He had continuously pursued the subject of transformer reliability and will long be remembered by those of us on this working group and task force.

The following persons were on the balloting committee that approved this document for submission to the IEEE Standards Board:

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When the IEEE Standards Board approved this standard on June 19, 1986, it had the following membership:

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IEEE Guide for Reporting Failure Data for Power Transformers and Shunt Reactors on Electric Utility Power Systems

1. Scope and References

1.1 Scope

1.1.1

This guide addresses the reporting and statistical analysis of reliability of power transformers and shunt reactors used on electric utility power systems. Included are the following types and applications of transformers:

- power transformers
- autotransformers
- regulating transformers
- phase-shifting transformers
- shunt reactors
- HVDC converter transformers
- substation transformers
- transmission tie transformers
- unit transformers
- unit auxiliary transformers
- grounding transformers

For the purpose of abbreviation in this document, the term “transformers(s)” refers to “power transformer(s) and shunt reactor(s).” For further clarification of the meaning of “transformer” as used in this guide, refer to the definitions and 6.5.5 and 6.5.6.

1.1.2

Types of transformers not covered by these guidelines include:

- rectifier transformers
- furnace transformers
- mobile transformers
- dry-type transformers

transformers on industrial and commercial power systems (ANSI/IEEE Std 493-1980 [6]¹ applies to these transformers)
 electronic transformers
 instrument transformers
 distribution transformers

1.1.3

The guidelines set forth in this document cover the format for the collection and reporting of data. This guide illustrates the kinds of reports that may be useful to both users and manufacturers of transformers.

1.1.4

The user is cautioned in the direct use of the historical data collected for predicting reliability of future installations. These data are useful in pointing out areas of concern in design, application, installation, operation, and maintenance of transformers and shunt reactors that should be considered when predicting future reliability.

1.1.5

Although the primary scope of this document is the reliability statistic called “failure rate,” it is also recognized that users of the suggested data base may also wish to tabulate and report statistics related to product quality, maintenance, and operating procedures.

CAUTION — Terms such as “failures with a scheduled outage” and “defects” fall into this area of quality reporting and should not be used to develop the statistic called “failure rate.” Defects and failures with a scheduled outage should be tabulated for purposes of immediate and ongoing feedback to manufacturers and operating groups for the improvement of reliability.

1.2 References

[1] ANSI C84.1-1982, American National Standard Voltage Ratings for Electric Power Systems and Equipment (60 Hz).²

[2] ANSI C92.2-1981, American National Standard Preferred Voltage Ratings for Alternating-Current Electrical Systems and Equipment Operating at Voltages Above 230 Kilovolts Nominal.

[3] ANSI/IEEE C57.12.80-1978, IEEE Standard Terminology for Power and Distribution Transformers.³

[4] ANSI/IEEE C57.21-1981, IEEE Standard Requirements, Terminology and Test Code for Shunt Reactors Over 500 kVA.

[5] ANSI/IEEE Std 100-1984, IEEE Standard Dictionary of Electrical and Electronics Terms.

[6] ANSI/IEEE Std 493-1980, IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems.

[7] Edison Electric Institute, Electrical System and Equipment Committee. Power Transformer Trouble Report—2.5 MVA and Larger.

¹The numbers in brackets correspond to those of the references listed in 1.2 of this standard.

²ANSI publications can be obtained from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

³ANSI/IEEE publications can be obtained from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018, or from the Institute of Electrical and Electronics Engineers, Service Center, Piscataway, NJ 08854-4150.

[8] ELECTRA No 88, May 1983. An International Survey on Failures in Large Power Transformers in Service. Paper presented by the Study Committee (Transformers) of Working Group 12.05: A. Bossi (Italy, Convenor), J. E. Dind (Canada), J. M. Frisson (Belgium), U. Khoudiakov (USSR), H. F. Light (USA), D. V. Narke (India), Y. Tournier (France), J. Verdon (France).

2. Definitions

The definitions of terms contained in this document are not intended to embrace all meanings of the terms, but are applicable to the subject treated in this guide.

2.1 accumulated service years: The length of time the transformer is operating from its in-service date until it is retired from service. It is suggested that de-energized time of three months or more not be considered in-service time. See 5.3.2 and 6.5.29.

2.2 component: A part within or associated with a transformer that is viewed as an entity. This is usually a replaceable part, for example, main winding, tap changer motor, etc.

2.3 failure: The termination of the ability of a transformer to perform its specified function. In the study of power transformer reliability, it is often difficult to distinguish between major and minor failures; therefore, the following failure definitions are given.

2.3.1 failure with forced outage: Failure of a transformer that requires its immediate removal from service. This is accomplished either automatically or as soon as switching operations can be performed.

2.3.2 failure with scheduled outage: Failure for which a transformer must be deliberately taken out of service at a selected time.

2.3.3 defect: Imperfection or partial lack of performance that can be corrected without taking the transformer out of service.

2.4 failure rate: The ratio of the number of “failures with forced outages” of a given population over a given period of time, to the number of accumulated service years for all transformers in that population over the same period of time.

NOTE —The failure rate defined here is composed of “failures with forced outages.” This is used for statistical analysis in system mathematical studies. Other reports may be made using “failure with scheduled outages” and “defects.” Tabulation of scheduled outages and defects needs to be aggressively pursued from the standpoint of reliability improvement. It should be recognized that reliability improvement is different from reliability measurement. Quantitative, mathematically correct, reliability measurement can only be accomplished by counting “failures with a forced outage.” Reliability improvement, on the other hand, can be accomplished through tabulating and reporting a wide variety of problems.

2.5 population: Transformers that have given common specific characteristics.

2.6 reliability: The probability that a transformer will perform its specified function under specified conditions for a specified period of time.

2.7 repair: Any operation that requires the dismantling, modification, or replacement of transformer components that results in restoring the transformer to normal service quality.

2.8 shunt reactor: A reactor intended for connection in shunt to an electric system for the purpose of drawing inductive current. See ANSI/IEEE C57.21-1981 [4], 2.1.2.

2.9 transformer: A static electric device consisting of a winding, or two or more coupled windings, with or without a magnetic core, for introducing mutual coupling between electric circuits. See ANSI/IEEE C57.12.80-1978 [3], 2.1.1.

NOTE—The transformer includes all transformer-related components, such as bushings, LTC's, fans, temperature gauges, etc., and excludes all system-related components, such as surge arresters, grounding resistors, high-voltage switches, low-voltage switches, and house service equipment.

2.10 user: The owner of the transformer.