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Guide for the statistical analysis of electrical insulation breakdown data

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CONTENTS

FOREWORD 4
IEEE Introduction 7

1. Scope 8

2. References 8

3. Steps required for analysis of breakdown data 9

3.1 Data acquisition 9
3.2 Characterizing data using a probability function 10
3.3 Hypothesis testing 11

4. Probability distributions for failure data 12

4.1 The Weibull distribution 12
4.2 The Gumbel distribution 13
4.3 The lognormal distribution 13
4.4 Mixed distributions 13
4.5 Other terminology 14

5. Testing the adequacy of a distribution 14

5.1 Weibull probability data 14
5.2 Use of probability paper for the three-parameter Weibull distribution 15
5.3 The shape of a distribution plotted on Weibull probability paper 16
5.4 A simple technique for testing the adequacy of the Weibull distribution 16

6. Graphical estimates of Weibull parameters 17

7. Computational techniques for Weibull parameter estimation 17

7.1 Larger data sets 17
7.2 Smaller data sets 18

8. Estimation of Weibull percentiles 19

9. Estimation of confidence intervals for the Weibull function 19

9.1 Graphical procedure for complete and censored data 20
9.2 Plotting confidence limits 21

10. Estimation of the parameter and their confidence limits of the log-normal function 21

10.1 Estimation of lognormal parameters 21
10.2 Estimation of confidence intervals of log-normal parameters 22

11. Comparison tests 22

11.1 Simplified method to compare percentiles of Weibull distributions 23

12. Estimating Weibull parameters for a system using data from specimens 23

Annex A (informative) Least squares regression 24

Annex B (informative) Bibliography 48

Annex C (informative) List of participants 49

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GUIDE FOR THE STATISTICAL ANALYSIS OF ELECTRICAL INSULATION BREAKDOWN DATA

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IEEE Std	FDIS	Report on voting
930 (2004)	112/59/FDIS	112/69A/RVD

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IEEE Guide for the Statistical Analysis of Electrical Insulation Breakdown Data

Sponsor

Statistical Technical Committee
of the
IEEE Dielectrics and Electrical Insulation Society

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Approved 23 September 2004

IEEE-SA Standards Board

Abstract: This guide describes, with examples, statistical methods to analyze times to break down and breakdown voltage data obtained from electrical testing of solid insulating materials, for purposes including characterization of the system, comparison with another insulator system, and prediction of the probability of breakdown at given times or voltages.
Keywords: breakdown voltage and time, Gumbel, Lognormal distributions, statistical methods, statistical confidence limits, Weibull

IEEE Introduction

This introduction in not part of IEEE Std 930-2004, IEEE Guide for the Statistical Analysis of Electrical Insulation Breakdown Data.

Endurance and strength of insulation systems and materials subjected to electrical stress may be tested using constant stress tests in which times to breakdown are measured for a number of test specimens, and progressive stress tests in which breakdown voltages may be measured. In either case it will be found that a different result is obtained for each specimen and that, for given test conditions, the data obtained may be represented by a statistical distribution.

Failure of solid insulation can be mostly described by extreme-value statistics, such as the Weibull and Gumbel distributions, but, historically, also the lognormal function has been used. Methods for determining whether data fit to either of these distributions, graphical and computer-based techniques for estimating the most likely parameters of the distributions, computer-based techniques for estimating statistical confidence intervals, and techniques for comparing data sets and some case studies are addressed in this guide.

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GUIDE FOR THE STATISTICAL ANALYSIS OF ELECTRICAL INSULATION BREAKDOWN DATA

1. Scope

Electrical insulation systems and materials may be tested using constant stress tests in which times to breakdown are measured for a number of test specimens, and progressive stress tests in which breakdown voltages may be measured. In either case, it will be found that a different result is obtained for each specimen and that, for given test conditions, the data obtained may be represented by a statistical distribution. This guide describes, with examples, statistical methods to analyze such data.

The purpose of this guide is to define statistical methods to analyze times to breakdown and breakdown voltage data obtained from electrical testing of solid insulating materials, for purposes including characterization of the system, comparison with another insulator system, and prediction of the probability of breakdown at given times or voltages.

Methods are given for analyzing complete data sets and also censored data sets in which not all the specimens broke down. The guide includes methods, with examples, for determining whether the data is a good fit to the distribution, graphical and computer-based techniques for estimating the most likely parameters of the distribution, computer-based techniques for estimating statistical confidence intervals, and techniques for comparing data sets and some case studies. The methods of analysis are fully described for the Weibull distribution. Some methods are also presented for the Gumbel and lognormal distributions. All the examples of computer-based techniques used in this guide may be downloaded from the following web site "http://grouper.ieee.org/groups/930/IEEEGuide.xls." Methods to ascertain the short time withstand voltage or operating voltage of an insulation system are not presented in this guide. Mathematical techniques contained in this guide may not apply directly to the estimation of equipment life.

2. References

The following publications may be used when applicable in conjunction with this guide. When the following standards are superseded by an approved revision, the revision shall apply.

ASTM D149-97a(2004) Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.[1]

[1]ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (http://www.astm.org/).

BS 2918-2, Methods of test for electric strength of solid insulating materials.[2]

IEC 60243 series, Electrical strength of insulating materials—Test Methods—Part 1: Tests at power frequencies. [3]