

IEEE Std 442-1981

(reaffirmed 2003)

IEEE Guide for Soil Thermal Resistivity Measurements

Sponsor
**Insulated Conductors Committee
of the
IEEE Power Engineering Society**

Reaffirmed 2003
IEEE Standards Board

Copyright © 1981 by

**The Institute of Electrical and Electronics Engineers, Inc
345 East 47th Street, New York, NY**

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 which 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 once 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 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
345 East 47th Street
New York, NY 10017
USA

Foreword

(This Foreword is not a part of IEEE Std 442-1981, IEEE Guide for Soil Thermal Resistivity Measurements.)

Throughout the years, many utilities, consultants, and testing firms have measured soil thermal resistivity both in situ and in the laboratory on selected soil samples. Such measurements have utilized various types of equipment and measurement techniques. In many cases, these testing methods have yielded inaccurate or inconsistent measurements of soil thermal resistivity. This has been attributed to the unavailability of commercial testing equipment and the lack of standardization associated with the measurements.

The Insulated Conductors Committee, recognizing the need for industry guidelines for the measurement of soil thermal resistivity, organized a working group of Subcommittee 12, Tests and Measurements, to write this needed guide. During the preparation of this guide, members of the working group made many round-robin tests and measurements on selected soil samples. The expertise developed during these tests is reflected in many parts of this guide.

The IEEE will maintain this guide current with changes in the state of technology. However, comments or suggestions for additions are invited on this guide. These should be addressed to:

Secretary
IEEE Standards Committee
Institute of Electrical and Electronics Engineers, Inc
345 East 47th Street
New York, NY 10017
USA

The membership and individuals contributing to the writing of this guide and the performance of the round-robin tests consisted of the following:

M. A. Martin, Jr, Chair

Mr. A. F. Baljet
Mr. R. A. Bush
Mr. D. Clarke

Mr. J. R. Easterling
Mr. M. L. Fenger
Mr. S. W. Margolin

Mr. J. J. Rueckert
Mr. J. Stolpe
Dr. W. W. Welna

At the time this guide was approved the members of the Test and Measurements Subcommittee were:

T. A. Balaska, Chair

C. F. Ackerman
E. M. Allam
A.M. Aubrey
A. T. Baker
A. F. Baljet
R. Bartnikas
E. W. Bennett
C. W. Baldes
L. A. Bondon
J. A. Bradley
R. A. Burkhardt
M. D. Calcumuggio
P. Chowdhuri
W. Cole
J. E. Conley

W. F. Constantine
J. N. Cooper
F. V. Cunningham
J. Densley
E. K. Duffy
G. S. Eager
N. W. Edgerton
R. M. Eichorn
A. Fitzpatrick
E. O. Forster
R.W. Foster
R. D. Fulcomer
J. B. Gardner
J. Garland
A. Garschick

D. W. Gasda
S. Gerhard
W.R. Goldbach
O.K. Gratzol
R. A. Guba
L. F. Hamilton
C. A. Hatstat
J. G. C. Henderson
W. J. Herbert
V. Herter
H. C. Hervig, Jr
R. R. Howard
H. I. Jehan
C. V. Johnson
R. J. Kasper

L. J. Kelly
W. B. Kenyon
F. Kimsey
M. Kopchik, Jr
J. R. Kushner
F. E. LaFetra
A. F. LaScala
J. S. Lasky
R. H. Lee
R. E. Leuch
T. H. Ling
R. Lukac
G. E. Lusk
R. Luther
E. A. MacKenzie
M. A. Martin, Jr
I. J. Marwick
E. J. McGowan
A. L. McKean
M. I. F. Monzon

C. E. Muhleman
J. H. Nicholas
M. G. Noble
H. Orton
J. J. Pachot
A. S. Paniri
W. M. Pate
J. R. Perkins
K. A. Petty
C. A. Pieroni
J. S. Pirrong
J. O. Punderson
J. G. Quin
P. H. Reynolds
N. M. Sacks
C. Saldivar
D. Sandwick y
E. L. Sankey
A. Sansores
G.W. Seman

J. J. Shortall
N. Singh
H. B. Slade
D. E. Soffrin
N. Srinivas
W. T. Starr
J. L. Steiner
R. Thayer
K. Tomori
R. T. Traut
P. D. Tuttle
J. R. Tuzinski
C. F. von Hermann
J. F. Wagner
E. M. Walton
R. H. W. Watkins
W. D. Wilkens
O. L. Willis
P. J. Wilson
R.T. Zukowski

When the IEEE Standards Board approved this standard on March 5, 1981, it had the following membership:

I. N. Howell, Jr, Chair
Irving Kolodny, Vice Chair
Sava I. Sherr, Secretary

G. Y. R. Allen
J. H. Beall
J. T. Boettger
Edward Chelotti
Edward J. Cohen
Warren H. Cook
Len S. Corey

Jay Forster
Kurt Greene
Loering M. Johnson
Joseph L. Koepfinger
J. E. May
Donald T. Michael *

F. Rosa
R.W. Seelbach
J.S. Stewart
W.E. Vannah
Virginius N. Vaughan, Jr
Art Wall
Robert E. Weiler

* Member emeritus

CLAUSE	PAGE
1. Scope	1
2. Purpose	1
3. References	1
4. Factors Influencing Soil Thermal Resistivity	2
4.1 Factors Influencing Measurements	2
4.2 Factors Influencing Application of Measured Soil Thermal Resistivity	3
5. Test Equipment	3
5.1 Equipment Required for Field Measurements	4
5.2 Equipment Required for Laboratory Measurements	5
6. Test Methods	5
6.1 Methods for Field Measurements	5
6.2 Methods for Laboratory Measurements	6
7. Analysis of Test Results	7
7.1 Sample Calculation	7
7.2 Interpretation of Results	8
Annex A Field Needle (Informative)	10
Annex B Laboratory Needle (Informative)	11
Annex C Slide Hammer Assembly (Informative)	12
Annex D Miniature Needle Data Sheet (Informative)	13

IEEE Guide for Soil Thermal Resistivity Measurements

1. Scope

This guide covers the measurement of soil thermal resistivity. A thorough knowledge of the thermal properties of a soil will enable the user to properly install and load underground cables. The method used is based on the theory that the rate of temperature rise of a line heat source is dependent upon the thermal constants of the medium in which it is placed. The designs for both laboratory and field thermal needles are also described in this guide.

2. Purpose

The purpose of this guide is to provide sufficient information to enable the user to select useful commercial test equipment, or to manufacture equipment which is not readily available on the market, and to make meaningful resistivity measurements with this equipment. Measurements may be made in the field or in the laboratory on soil samples or both.

If the native soil is to be tamped back into the trench at the same density at which it was removed, it may be desirable to make in-situ resistivity measurements along the route of the cable.

If the native soil is to be placed in the trench at a density different than undisturbed soil in the same vicinity, laboratory measurements are required on soil samples recompacted to the desired density.

In order to draw meaningful comparisons on selected foreign backfill materials, thermal resistivity measurements should be made in the laboratory on soils which are compacted so as to provide maximum dry densities.

3. References

[1] ANSI/ASTM D 698-78, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb (2.49 kg) Rammer and 12 in (305 mm) Drop¹

[2] ANSI/ASTM D 1557-78, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 kg) Rammer and 18 in (457 mm) Drop

¹ANSI documents are available from The American National Standards Institute, 1430 Broadway, New York, NY 10018.