SHORT CIRCUIT

CHARACTERISTICS OF

INSULATED CABLES

ANSI/ICEA PUBLICATION P-32-382-2007

Revised June 2007

Approved as an American National Standard
ANSI Approval Date: June 4, 2007

Insulated Cable Engineers Assoc., Publication No. P-32-382-Revised 2007

Short Circuit Characteristics Of Insulated Cables

Published by

Insulated Cable Engineers Association
P.O. Box 1568
Carrollton, Georgia 30112
www.icea.net

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

The Insulated Cable Engineers Association, Inc. (ICEA) standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together persons who have an interest in the topic covered by this publication. While ICEA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgements contained in its standards and guideline publications.

ICEA disclaims liability for personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. ICEA disclaims and makes no guaranty or warranty, expressed or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. ICEA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, ICEA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is ICEA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgement or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

ICEA has no power, nor does it undertake to police or enforce compliance with the contents of this document. ICEA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety-related information in this document shall not be attributable to ICEA and is solely the responsibility of the certifier or maker of the statement.

CONTENTS

Page

GRAPHS

Foreword

This publication discusses factors for consideration in approximating the operability of insulated and/or covered wire and cable under the influence of uninterrupted short circuit currents encountered as a result of cable or other equipment faults. The duration of such a fault is considered to be up to approximately 2 seconds. Calculation for single short circuits of longer durations yield increasingly conservative results.

The following items must be considered in order to estimate the short circuit performance of a specific circuit:

1. The magnitude and duration of the fault current including any fault current division due to available conducting paths.

2. The capability of joints, terminations and other accessories in the affected circuit to withstand the thermal and mechanical stresses created by the fault.

3. The interaction between the faulting circuit and surrounding equipment, such as supports, ties and clamps.

4. The capability of the affected cable circuit, as installed, to withstand the electromagnetic forces created during the fault.

5. The maximum temperature that cable components can withstand without incurring damage due to heating caused by fault current flow.

6. Damage to adjacent equipment due to arcing at the site of the fault.

7. For limitations imposed on the short-circuit capacity of the cable by the fault capacity of the cable metallic sheath/shield, See ICEA Publication P-45-482, *Short Circuit Characteristics of Metallic Sheaths and Shields on Insulated Cable*

An important simplifying assumption in the formula is the adiabatic nature of the heat generated, *i.e., the duration of the fault is so short that all the heat developed by the fault current during this time is assumed to be completely contained within the conductor.* The amount of heat dissipated from the conductor during continuous, single fault occurrences of relatively short duration is small. A significant amount of heat may be dissipated because of the relatively long cooling periods involved for faults interrupted and re-established with automatic reclosing of circuit protective devices. A non-adiabatic calculation may be more suitable for these situations and for single, uninterrupted short circuits in excess of 2 seconds requiring close accuracy. Non-adiabatic calculation methods are described in several published works listed Section 1.2 “References”.

The formula described in this publication is based on the thermal capacity of the conductor material and the transient temperature limit of the insulation. The quantity of heat contained in the conductor is that created by the fault current and is also a function of the temperature rise in the conductor. The magnitude of the temperature rise is the difference between the limiting transient temperature of the insulation material and the operating temperature of the conductor immediately prior to the initiation of the fault. The limiting transient temperature is that temperature which caused no significant change in any cable component.

Suggestions for improvements in this publication are welcome, and should be sent to ICEA at the address below.

Insulated Cable Engineers Association, Inc.
P.O. Box 1568
Carrollton, GA 30112

Section 1
GENERAL

1.1 SCOPE

Equations have been established for short circuit calculations for conductors made of copper or aluminum. The coverings and insulations, which determine the maximum allowable short circuit temperatures, are paper, varnished cloth and several thermoplastic and thermosetting materials presently appearing in ICEA standards. Temperature limits, considered safe, were established for the various covering and insulation materials.

The equations may be used to determine:

- The maximum short circuit permitted for a specific conductor and short circuit duration.
- The conductor size necessary to carry a specific short circuit current for a given duration.
- The maximum duration a specific conductor can carry a specific short circuit current.

A formula has been established for short circuit calculations with conductors of copper or aluminum. The insulations, which determine the maximum allowed short circuit temperatures, are described in the ICEA Standards. The formula is based on the heat content of the conductor material and the temperature limit of the insulation with the assumption that the time interval is so short that the heat developed during the short circuit is contained in the conductor. At the time this document was originally published there was no standard mathematical method available to calculate heat flow from the conductor through the insulation at the cessation of the short circuit load. It was necessary to enlist the aid and facilities of member laboratories and Massachusetts Institute of Technology to obtain in cooperation a solution to this problem so that safe temperature limits could be established for the various types of insulations. The solution is still a viable, conservative approach to the calculation of short circuit capacity.

Results are sufficiently conservative to neglect conductor skin-effect except for very large conductors. Skin-effect can be taken into account by dividing the right-hand member of the equations shown by the appropriate conductor ac/dc resistance ratio.

1.2 REFERENCES

The following publications were referred to in writing this standard.

The Transient Temperature Rise of Round Wire Shields of Extruded Dielectric Cables Under Short Circuit Conditions, M. A. Martin Jr., A.W. Reczek Jr., IEEE-ICC Open Forum at 57 Meeting Nov. 17-19, 1975.

Optimization of Design of Metallic Shield-Concentric Conductors of Extruded Dielectric Cables Under Fault Conditions, EPRI EL-3014, Project 1286-2, final Report 4/83.

Optimization of Metallic Shields for Extruded Dielectric Cables Under Fault Conditions, IEEE Paper 86 T&D 339-B.

Normal and Short Circuit Operating Characteristics of Metallic Shielded Solid Dielectric Power Cable, M.A. Martin Jr., D. A. Silver, R. G. Lukac, R. Suarez, IEEE Paper 973 495-9.