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SWITCHING SURGE TESTING

OF EXTRA-HIGH-VOLTAGE SWITCHES

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FOREWORD

This document is published to provide guidance in the switching surge testing of extra-high-voltage air switches. For the design and safe application of extra-high-voltage air switches, it is believed essential to have uniformity of test environment, test procedure, and interpretation of data in order to correlate data gathered in different laboratories and eliminate the wide variations that are now apparent in test results.

The Air Switch Working Group of the Switch, Fuse, Insulator Subcommittee has prepared this report and recognizes its obligation to continue efforts to improve or revise it in the light of knowledge derived from tests conducted in accordance with the report. After an appropriate period of use the report will be thoroughly reviewed by the Air Switch Working Group and the up-dated document will be the basis for the preparation of an IEEE Standard for the Switching Surge Testing of Extra-High-Voltage Switches. It is anticipated that this material will eventually be incorporated into USA Standard C37.34 and the paragraph numbering has been chosen to fit in with the system in that document.

It should be clearly understood that this document relates *ONLY* to air switches and it is not intended to be used as a basis for testing other electric apparatus particularly where such tests would be destructive to insulation.

This document when balloted in the Switchgear Committee for IEEE publication elicited several negative votes which expressed concern in the areas identified by paragraph numbers 2.5.6, 2.5.7, 2.5.11, 2.6 and Appendix A. Footnotes which explain the nature of the concern expressed by the negative ballots as well as by those who approved with comment are published adjacent to the aforementioned items. Since there was not complete agreement in these areas, this report should be used with the understanding that these items are likely to be revised before final publication as an official Standard.

It is recommended for switching surge testing programs that there be a thorough documentation of parameters related to the test so that subsequent conversion of data might be possible without duplicating test effort.

ACKNOWLEDGMENT

The Institute wishes to acknowledge its indebtedness to those who have so freely given of their time and knowledge, and have conducted experimental work on which many of the IEEE publications are based.

This publication was prepared by the Air Switch Working Group of the Switch, Fuse, and Insulator Subcommittee of the Switchgear Committee of the IEEE Power Group, whose membership was:

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34-2.5 SWITCHING SURGE TESTS OF EXTRA-HIGH-VOLTAGE SWITCHES

2.5.1 Equipment to be Tested. Outdoor air switches rated 345 kV and above may be required to withstand long-duration switching surge voltages. The test procedures described herein are basically intended to be for design purposes. Tests should be conducted on single-pole units in accordance with the following paragraphs.

2.5.2 Mounting Arrangement. The single-pole sample to be tested should be mounted at the minimum expected service height above a ground plane extending in all directions from the switch base for a distance of at least twice the switch open gap dimension. In the absence of other specification, the mounting height should be such that the lowest point of the switch insulators is no more than 8 feet above the ground plane for 345-kV equipment, 12 feet above the ground plane for 500-kV equipment, and 16 feet above the ground plane for 700-kV equipment.

2.5.3 Electric Conductors. In the absence of other specification, an electric conductor of the size normally intended for use with the switch should be connected to each switch terminal and should extend horizontally for a distance of 10 feet. These conductors may be terminated with suitable shielding means to prevent flashover from their ends.

2.5.4 Proximity of Other Objects. The switch should be mounted in an environment which is free from objects which can significantly distort the electric field distribution when the switch is energized. Grounded metallic objects should be no closer to energized portions of the switch than 1.5 times the switch open gap dimension.

2.5.5 Points of Application of Voltage. Dielectric characteristics of the specimen should be determined by the application of positive and negative switching surge voltages as follows:

- (1) With the switch closed and dry, test voltages should be applied between the energized parts and the grounded metal parts including the base.
- (2) With the switch open and dry, test voltages should be successively applied between each terminal and the grounded metal parts including the base with the other terminal connected to ground.

- (3) The above tests (1) and (2) should be repeated with wet conditions in accordance with USA Standard C77.1. As an alternate, wet conditions in accordance with IEC Publication 129 may be used.

2.5.6 Number and Magnitude of Voltage Applications. (See Footnote 1.) Dielectric characteristics should be determined by applying to the test switch a series of at least 20 standard surges of the same crest value at each of at least four voltage steps. The lowest voltage level test point should be such that three to five flashovers occur to ground. The highest voltage level test point should be such that 15 to 17 flashovers occur. The two intermediate points should be selected so that the spacing between the four points is approximately equal. For each voltage level, the number of flashovers and the number of withstands should be recorded.

2.5.7 Switching Surge Wave Shape. (See Footnotes 2 and 2a.) The switching surge wave for dielectric testing purposes should consist of a unidirectional surge voltage, rising to its crest value in a time in the range of 70-250 microseconds and decaying to one-half value in a time not less than 3000 microseconds. The time to crest should be taken as 1.67 times the time required to reach 90 percent of crest on the front of the wave. When due to instrumentation the zero time is

Footnote 1

It was proposed that a more accurate withstand determination could be made with fewer tests if statistical methods were used.

Footnote 2

The stipulation of a wave shape and the way to measure it drew the most comment. The Air Switch Working Group will be most receptive to considering industry wide proposals that are made before attempting to have this item become a final IEEE Standard.

It should be noted that the alternate method proposed in this report varies slightly from the IEC impulse method of 1.67 times the time from 30 percent to 90 percent voltage. It is felt that 2 rather than 1.67 gives a better measure of actual time to crest.

It is recommended that when the waves as recorded on oscillograms are being measured as specified, that the time to crest as determined visually also be recorded for purposes of correlation at a later date.

Footnote 2a

As of the date of publication of this report the Techniques for Dielectric Tests Subcommittee of the Power System Instrumentation and Measurements Committee of IEEE (also USASI C68) has taken action to recommend to the industry the visual or real-time method of measurement of switching surge wave shape characteristics recorded on oscillograms.