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Application Guide For Ceramic Suspension Insulators

NEMA

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APPLICATION GUIDE FOR CERAMIC SUSPENSION INSULATORS

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Foreword

This document is intended to provide guidelines for the proper use of insulators and to suggest precautions to be taken against improper usage that may not be readily apparent to the user. It is stressed, however, that these are only guidelines, and direct consultation between the user and the manufacturer is recommended.

This edition of the document is a revision of NEMA Standards Publication HV 2-1984.

The need for this guide was indicated by the knowledge of customers' experiences which manufacturers of suspension insulators gained over many years. Your comments are welcomed, and should be submitted to:

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Scope

This document is intended to guide users in the proper application of ceramic (porcelain and toughened glass) suspension insulators and to point out the means whereby the power lines on which suspension insulators are used can provide even higher levels of reliability than are being realized today.

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APPLICATION GUIDE FOR CERAMIC SUSPENSION INSULATORS

Section 1
INTRODUCTION

Insulators of essentially the same basic design as today's insulators have been providing reliable service for more than 50 years. There are many millions of insulators in use throughout the world, yet insulator failures are extremely rare. Still more reliability is attainable by recognizing and compensating for the limitations pointed out in this guide.

Manufacturers make insulators which are capable of providing a high degree of reliability. However, since suspension insulators are both structural members and electrical apparatus, it is equally important that they be properly utilized, handled, stored, applied, installed, and maintained.

It is hoped that the following discussion will be helpful to the user (1) in understanding the limitation of insulators, (2) in providing an additional interpretation of American National Standard C29.2-1992, *—*Wet-Process Porcelain and Toughened Glass—Suspension Type*, and (3) in specifying the proper insulator for the required service.

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Section 2
MATERIALS

Suspension insulators consist of ceramic materials and metal components assembled with cement. The ceramic materials and cement are hard and nonductile, and some metal components are protected with a heavy zinc coating. However, damage may occur due to chipping, abrasion, or corrosion.

2.1 CHIPPING

Modern insulators have high impact strength, but the ceramic material can be broken unless care is exercised in handling. When any visible section of the ceramic has been broken off, including chips, the user should discard the insulator.

2.2 ABRASION

Excessive abrasion, causing roughening of the surface, will reduce the ability of the insulator to shed pollutants. If abrasion exposes the base ceramic, a loss in the mechanical strength of the insulator may result. The zinc coating can be damaged by excessive abrasion, exposing the base metal to corrosion.

2.3 CORROSION

Corrosive atmospheres may damage ceramic and metal, and it is advisable to discuss applications in such atmospheres with the manufacturer.

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Section 3
HANDLING

Suspension insulators are subject to a wide variety of handling procedures from initial shipment to installation on the power line; therefore, the precautions listed in 3.1 through 3.3 should be observed:

3.1 Insulators should not be dropped or thrown while still in their containers or after being unpacked. Insulators which have been dropped should be inspected and tested prior to installation.

3.2 Insulator strings should not be bent as bending is likely to deform the insulator pin or clevis cap or to damage the ceramic material. Such damage, if undetected, may subsequently cause mechanical or electrical failure. In the case of ball-and-socket-type insulators, bending may also cause flattening or twisting of the legs of the cotter keys, resulting in loss of the locking feature.

3.3 Insulator strings should not be used as ladders by line personnel. The insulators are not designed for loading on the skirts and may break, causing injury to personnel. They may also become chipped or cracked.

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Section 4
FIELD INSPECTION

4.1 Insulators should be individually inspected at the time of initial construction to assure that sound units, which have not been damaged by harsh shipping or handling procedures, are installed. Units with chipped or cracked ceramic should be discarded and companion units in the same crate or pallet should be carefully inspected. If the condition of the crate or insulators indicates undue handling abuse, all units should be tested to assure their soundness.

4.2 Cotter keys of ball-socket insulators should be individually inspected as an indication of possible handling abuse. No twisting, flattening, or indentations should appear, as this is evidence of compressive, impact, or bending loads, which the insulator is not designed to withstand. Any insulators with such cotter damage should be tested before installation and the cotter should be replaced.

4.3 Final inspection of the line after construction should include a similar examination of the cotter condition, to guard against damage incurred during construction. Also, a severely deformed cotter could allow uncoupling in service.

4.4 Suspension insulators which are suspected of having been exposed to harsh shipping, abusive handling, or service impacts should be tested prior to installation. The manufacturer should be contacted for recommended test procedures.

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Section 5
INSTALLATION

5.1 COUPLING AND UNCOUPLING

When insulators are coupled together, precautions should be taken to assure that the coupling is properly done.

Ball-and-socket connections are secured by a humped cotter key. In order to couple the ball with the socket, the cotter key should be pulled or pushed away from the socket opening until the spread tips of the key bear against the back of the socket. When the key is in this position, the ball on the insulator pin can be engaged with the socket of the next insulator cap. Then, the key should be pushed back toward the socket opening, making certain that both legs of the key are under the ball of the engaged insulator. Care should be exercised to move the key sufficiently so that the hump of the key passes through the cap wall, thus providing a positive locking. Uncoupling the joint requires a reversal of this procedure and should be done with tools made for this purpose.

In coupling clevis-type insulators, the cotter keys should be properly engaged. In the case of the humped-type key, the hump should pass through the cotter bolt and be locked. In the case of the straight key, the open legs should be bent sufficiently to guard against the retreat of the key back through the hole in the cotter bolt.

5.2 COTTER KEYS AND BOLTS

When recoupling insulators which have been in service, all damaged cotter keys should be replaced. Undamaged humped-type keys are reusable, but straight keys are not.

When cotter keys or bolts are replaced, a key or bolt supplied by the manufacturer of the particular insulator should be used since the keys and bolts of different manufacturers are not necessarily interchangeable.

5.3 BENDING OF INSULATOR STRINGS

Suspension insulators are designed for tension loads only, and bending and cantilever loading of insulator strings must be avoided. All insulators with bent metal components should be replaced.

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Section 6
RATINGS

All mechanical and electrical ratings of suspension insulators are assigned by the insulator manufacturer. They are not minimum values. The demonstration that the insulator meets its ratings is based upon statistical criteria as defined in American National Standards C29.1-1988, *Test Methods for Electrical Power Insulators*, and C29.2-1992, *Insulators—Wet-Process Porcelain and Toughened Glass—Suspension Type*, and as measured on new insulators under certain specified test conditions.

6.1 FLASHOVER RATING

Flashover ratings are the average expected flashover values under specified test conditions of clearance and mounting on new and clean insulators. Atmospheric conditions which prevail at the time of test are not controlled, and, while correction factors for humidity and air density are applied, these factors are not precise numbers. It can be expected that different atmospheric conditions will yield different test results. As is the case for any average value, half of the values may be expected to fall below the average value.

6.2 LEAKAGE DISTANCE RATINGS

Rated leakage distances are nominal average values and may vary within the normal manufacturing tolerance which, for most manufacturers, is 3 percent.

6.3 ULTIMATE MECHANICAL AND ELECTRICAL STRENGTH RATING (See 6.4)

The combined mechanical and electrical strength rating assigned to suspension insulators refers to ultimate strength and not to tension proofload. Since the ultimate strength can be measured only by destructive tests, the probability of any unit falling below the combined mechanical and electrical strength rating is estimated on the basis of the statistical quality controls required by American National Standards C29.1-1988 and C29.2-1992.

Statistical analysis of the test data obtained from a sample of the lot will demonstrate whether or not the lot from which the insulators were taken show compliance with the rating. The actual strengths of the insulators tested will follow some form of distribution pattern, and there exists the possibility that one of the insulators in the test sample may fall below the rating, and yet the test sample as a whole may show compliance with the rating. There is the greater possibility that in any large quantity of insulators represented by the test sample there will be some insulators which have ultimate strengths less than the rating.

6.4 TENSION PROOF LOAD RATING

The tension proof load rating is the load which is withstood by each new insulator for the brief period specified in American National Standard C29.1-1992.

When identified by the word "TEST," the value marked on the insulator indicates the tension proof load. If not identified by the word "TEST," or if identified by the symbol "M&E," the value represents the mechanical and electrical strength rating of the insulator.

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Section 7
LOADING

7.1 Insulators are used in tension as structural members. It is important that a clear understanding exist regarding the types and magnitudes of loads and the safety factors which should be applied in the use of the insulators.

7.2 The user should consider the following factors in his design, taking into account both construction and operating conditions:

7.2.1 Maximum Load

It is recommended that the maximum combined load not exceed the tension proof load. Usage above this load entails increased risk of failure. The maximum combined load includes static and dynamic loads during construction and maintenance as well as during operation.

7.2.1.1 Static Load

All anticipated sources of static load should be included in the user's appraisal of the specific application. These include, but are not limited to, line tension, ice, wind, effects of temperature, weight of insulators and hardware, and maintenance.

7.2.1.2 Dynamic Load

Just as in the case for static loads, all anticipated sources of dynamic load should be included in the user's appraisal of the specific application. These dynamic loads include, but are not limited to, shock, impact, and vibration.

7.2.2 Construction and Maintenance

Care should be exercised to assure that the tension proof load is not exceeded during construction and maintenance. Bending and cantilever loads should be avoided, and for clevis-type hardware twisting should also be avoided.

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Section 8
SERVICE LIMITATIONS

Some of the limitations which should be considered are listed in 8.1 through 8.4.

8.1 HIGH FREQUENCY

Suspension insulators are designed for use at power frequencies and may be unsatisfactory for use at higher frequencies because of increased power loss and internal heating.

8.2 EXTREME TEMPERATURES

The normal operating range for ceramic insulators is -40°F to +150°F (-40°C to +65.6°C). If application is contemplated outside this range, consultation with the manufacturer is recommended.

8.3 VIBRATION

Vibration can cause fatigue in the hardware components of an insulator, especially the ball bolt of a ball-and-socket insulator.

8.4 CORROSION

Corrosive atmospheres will cause damage and, hence, a shortened life for insulators. Insulators which are exposed to such atmospheres should be inspected frequently.

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Section 9
DAMAGED INSULATORS

9.1 Where major damage has occurred on a transmission system, it is recommended that the insulators in the local area of damage be replaced regardless of whether they actually show signs of damage. For example, if a tornado damages a tower, all insulators on that tower should be replaced, and consideration should be given to replacing insulators on adjacent towers.

9.2 In those instances where a string of insulators has sustained flashover in which power currents are involved, it is recommended that the user replace all damaged insulators.

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NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

(Standardization Policies and Procedures, p. 1)

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 2)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.

(Standardization Policies and Procedures, p. 8)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes:

1. NEMA Standard, which relates to a product, process or procedure commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.
3. Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

(Standardization Policies and Procedures, pp 7 & 16)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.

(Standardization Policies and Procedures, pp. 7 & 16)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment and/or approval, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon. *(Standardization Policies and Procedures, pp 7 & 16)*

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

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HIGH VOLTAGE INSULATORS SECTION
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MEMBER COMPANIES

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Cooper Power Systems
Subsidiary of Cooper Industries, Inc.
Franksville, WI 53126

The Ohio Brass Company
Subsidiary of Hubbell Inc.
Wadsworth, OH 44281-0902

Lapp Insulator Company
Le Roy, NY 14482

Locke Insulators, Inc.
Baltimore, MD 21230

Newell Porcelain Co., Inc.
Newell, WV 26050

Porcelain Products Company
Carey, OH 43316

Reliable Power Products, Inc.
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Sediver, Inc.
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