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COOPER POWER SERIES

Test Report

1.2kV to 2.5kV

3010 Ampere

Cast Aluminum Spade / Spade

Secondary Low Voltage Bushing

Powering Business Worldwide

Design Tests for the Eaton

1.2 kV to 2.5 kV

3010 Ampere

Cast Aluminum Spade / Spade

Secondary Low Voltage Bushing

Part Numbers:

Bushings with in-line internal spade:

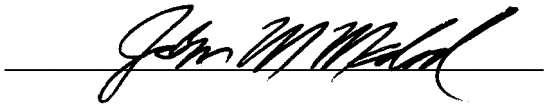
2690131D06
2690131D12
2690131D16
2690131D07

Bushings with 90^{O} internal spade:

2690476D21
2690476D22
2690476D23
2690476D24

CERTIFICATION

Statements made and data shown are, to the best of our knowledge and belief, correct and within the usual limits of commercial testing practice.



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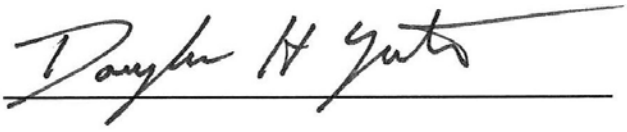

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Introduction

This report details the testing performed on Eaton's 3010 ampere cast aluminum secondary low voltage bushings with internal and external spades. The testing was done to verify that the bushings meet all known performance requirements for use in oil filled distribution transformers. Current and voltage ratings are in accordance with IEEE Std C57.12.00, "IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers". The bushings have a published service voltage rating of 1.2kV but were tested at and met the requirements for a 2.5kV system rating. All testing was performed in accordance with accepted test practices.

Contents

SECTION A

Leak / Seal, Thermal Cycle and Cantilever Leak / Seal Tests

Background
Secondary low voltage bushings, when used in oil filled transformers, might be exposed to temperature extremes and cantilever loads which could cause the bushings to leak or otherwise fail.

Object
Leak testing before and in combination with a cantilever load, after thermal cycling, will test the seal between the insulation and the cast aluminum conductor. The test protocol will verify that the seal will withstand the temperature extremes without leaking or being otherwise damaged.

Procedure
Bushings were first tested for seal integrity by being subjected to 30 psig of air in a fixture submerged under water. The bushings were then thermal cycled ten (10) times in an environmental chamber between -30 ^{O}C and 130 ^{O}C, with a dwell time of at least 60 minutes at each extreme. The seal integrity was retested at 15 psig of air with a 100 ft.-lb. cantilever load applied.

Results
There was no evidence of leaking, chipping or cracking as a result of being tested as described above.

Conclusions
The 3010 ampere cast aluminum spade / spade low voltage bushings passed the leak/seal, thermal cycle and cantilever load tests to which they were subjected without leaking.

SECTION B

Continuous Current
Temperature Rise Test

Background
Secondary low voltage bushings will experience the same continuous current as the transformer they are mounted on. Therefore, they must be tested in accordance with IEEE Std C57.12.00, which limits the temperature rise of the top level of oil to 65 ^{O}C above a 20 ^{O}C ambient and the winding hottest spot temperature and any point on the oil side of the bushings to a maximum of 15 ^{O}C above the top oil temperature.

Object
Demonstrate that the temperature at no point on the oil side of the bushing exceeds 15 ^{O}C above top oil temperature of 85 ^{O}C when tested to stability at 100% of rated current.

Procedure
Bushings were mounted to an oil filled tank to closely simulate, in a laboratory environment, an actual assembly.
Apply the 3010 amperes RMS rated load current. Thermocouples were applied to representative locations on the internal spade, leads, top oil and air ambient to monitor the temperature. The current was maintained until there was not more than a 1 ^{O}C variation between top oil and internal bushing spade temperatures over a two (2) hour period.

Results
The internal spade of all bushings stabilized at temperatures less than the required 15 ^{O}C above the top oil temperature.

Conclusions
The 3010 ampere cast aluminum spade / spade low voltage bushings passed the temperature rise requirement at rated full load continuous current.

SECTION C

Impulse Voltage (BIL) Withstand Test

Background
Secondary low voltage bushings shall withstand an impulse voltage of 45 kV BIL as specified for a 2.5 kV class voltage system in IEEE Std C57.12.00, Table 13 for outdoor distribution transformer bushings.

Object
Demonstrate that the bushing will withstand the 45 kV impulse voltage at both positive and negative polarities for a 2.5 kV class system without flashover. Determine the maximum withstand and flashover levels at both polarities.

Procedure
Bushings were installed to an oil filled tank simulate the mounting arrangement on a transformer front plate. Tests were conducted at room ambient temperature. Each bushing was subjected to three (3) each positive and negative polarity impulses at 45 kV crest value having a 1.2 x 50 microsecond wave shape. The voltage was then raised in 5 kV increments (three impulses at each polarity) until two (2) out of (3) flashovers occurred.

Results
The insulation on all bushings withstood the rated 45 kV (BIL) crest impulses without flashover. The maximum impulse withstand voltage was determined to be at least 50 kV crest for both polarities. Flashovers occurred at 55 kV crest or higher.

Conclusions
The 3010 ampere cast aluminum spade / spade low voltage bushings passed the 45 kV minimum dielectric impulse withstand voltage for 2.5 kV class voltage systems without flashover.

SECTION D

60 Hz AC High Voltage Withstand Test

Background
Secondary low voltage bushings shall withstand a 1-minute 60 Hz AC voltage at 10 kV as specified for a 2.5 kV class voltage system in IEEE Std C57.12.00, Table 13 for outdoor distribution transformer bushings.

Object
Demonstrate that the bushing will withstand the 10 kV 60 Hz AC voltage for a 2.5 kV class system without flashover. Determine the maximum withstand and flashover levels.

Procedure
The same bushings as used in the impulse withstand test, Section C, were installed to an oil filled tank simulate the mounting arrangement on a transformer front plate. Tests were conducted at room ambient temperature. Each bushing was subjected to 15 kV, 60 Hz, voltage level for 5 minutes. The voltage was then raised at a rate of 2 kV/second until flashover.

Results
The insulation on all bushings withstood the rated 10 kV 60 Hz AC voltage for 5-minutes without flashover. The maximum 60 Hz AC withstand voltage was determined to be at least 25 kV with flashovers ranging between 28.0 and 38.8 kV.

Conclusions
The 3010 ampere cast aluminum spade / spade low voltage bushings passed the 10 kV 60 Hz 1-minute AC withstand voltage for 2.5 kV class voltage systems without flashover.

SECTION E

Short Circuit Current Withstand (Momentary) Test

Background
Secondary low voltage bushings will experience the same continuous current as the transformer they are mounted on. Therefore, the bushing must be tested in accordance with IEEE Std C57.12.00 for short circuit current tests and levels.

Object
Demonstrate that the insulation on the bushing will not be damaged when subjected to fault currents and durations required for Category I and Category II transformer applications. For Category II applications the transformer was considered to have an impedance of 5.75%.

Procedure
Bushings were connected in series in a physical arrangement simulating the front plate of a transformer. The bushings were subjected to six (6) applications of 52.4 kA RMS (17.4 x 3010 A rating) with five (5) of the six (6) having a duration of 15 cycles, any two (20 at full asymmetry, and the sixth having a duration of 120 cycles. Ten (10) minutes were allowed between current applications. The bushings were inspected for damage after each current application.

Results
No damage to the insulation or cast spades and no leaks were observed to have occurred on any bushing after completion of the test.

Conclusions
The 3010 ampere cast aluminum spade / spade low voltage bushings withstood the 52.4 kA momentary fault current levels required for Categories I and II applications without damage.

Revisions

Revision No.	Date	What was added/changed:
00	10/21/1992	Initial test report issued.
01	06/01/2015	• Test re-issued in Eaton format. • New Eaton number assigned. Was CP-9231 Rev. 00 (also E-9219) • Added the voltage rating to the Title Page and throughout the report. • Introduction, page 4, changed to indicated that bushings were tested at and met requirements for a 2.5kV rating. • Reference standard changed to IEEE Std C57.12.00, was ANSI Std C57.12.00. • Certification signatories, page 2, were Frank J. Muench and Larry A. Lesch

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