UNIVERSITY OF WOLLONGONG

AUSTRALIAN POWER QUALITY AND RELIABILITY CENTRE
APQRC

Review of Testing Methodology applied to EPR Safety Mat

Report prepared for:
Lightning Protection International Pty Ltd

Final Report

Dr Vic Smith

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1 Executive Summary

Lightning Protection International Pty Ltd (LPI) has requested that the University of Wollongong (UOW) assess the methodology used to test a new type of personnel safety mat, the EPR Safety Mat, for use by persons in situations where step and touch voltage risks exist due to lightning discharges or other fault current scenarios.

The methodology used to test and verify the performance of the mat was assessed and found to be essentially sound.

The upper insulating surface of the mat was tested to an international standard (IEC 61000:2009) as required for electrical worker safety.

Due to the unique nature of the mat, its step and touch potential mitigation capability was not able to be assessed against a recognised standard. However, the two-part testing strategy using modelling via CDEGS software and field measurements during a Fall-of-Potential current injection test at an 11kV substation provide a means for good assessment of the impact of the mat on step and touch potentials.

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2 Introduction

Lightning Protection International Pty Ltd (LPI) has requested that the University of Wollongong (UOW) assess the methodology used to test a new type of personnel safety mat for use by persons in situations where step and touch voltage risks exist due to lightning discharges or other fault current scenarios.

This report is structured as follows. Section 3 will describe the product tested, indicating its unique features. Section 4 will establish what are the most appropriate standards that the product should be tested to. Section 5 will discuss the applicability of the test methods chosen by LPI to verify the safety mat's suitability. Section 6 will list conclusions and recommendations.

3 Description of Tested Product

The product tested is described by LPI as an EPR (Earth Potential Rise) Safety Mat [1]. The mat is intended to mitigate the step and touch potential hazards arising from network earth faults and lightning strikes.

The mat is said to achieve this mitigation by a unique structure of conducting layers overlaid with an insulating layer. The conducting layers are intended to redistribute the surface potentials in the vicinity of the electrical worker in order to reduce step and touch potentials. The insulating layer is meant to provide additional impedance to further reduce body current resulting from high touch potentials.

4 Applicable Standards

Being a unique product, no one standard applies directly to the EPR Safety Mat. Because of the intended use of this mat, it should as a minimum comply with a standard relating to high voltage (HV) safety matting.

The main standards applicable here are:

- IEC 61111:2009, "Live working – Electrical insulating matting" [2]
- ASTM D178-01(2010), "Standard Specification for Rubber Insulating Matting" [3]

Both of these standards are "applicable to electrical insulating matting made of elastomer for use as a floor covering for the electrical protection of workers on electrical installations" [2].

These standards specify a number of classes of mat depending on the maximum use voltage which in most cases would be the phase to earth potential of the system on which they are used. The class categories are the same for both standards.

No standard exists to specify how the EPR Safety Mat would be tested to verify its step and touch potential mitigation properties.

5 Discussion of Test Methodology Used

LPI has applied a two-part testing strategy to their EPR Safety Mat:

1. Testing the upper insulating layer to IEC 61111:2009, Class 1 [4];

2. Using a combination of simulation and field testing to verify the EPR mitigation capabilities of the mat [1].

Because of the intended use of this mat in or near electrical installations, it should as a minimum comply with a recognised standard relating to high voltage (HV) safety matting. IEC 61111:2009 [4] is suitable for this. The EPR Safety Mat was tested as a Class 1 mat suitable for maximum use AC voltages up to $7.5kV_{rms}$ i.e. for nominal system voltages up to $11kV_{rms}$. The test reports [4] indicate that all relevant tests specified in IEC 61111:2009 were performed. It is noted that an additional leakage current test, not in IEC 61111:2009, was done to IS 15652:2006 [5] although this standard has a slightly different class structure. This test gives an indication of the current which flows through the mat when it is subjected to the maximum use voltage of the class considered. The test reports [4] indicate that the test laboratory is TÜV SÜD certified.

Since no standard exists to specify testing to verify the step and touch potential mitigation capability of the EPR Safety Mat, LPI has used a combination of modelling and field testing to assess the effect of the mat on step and touch potentials.

Modelling has been done by means of the industry-standard software package CDEGS [6]. The scenario used was to examine the EPR effects of a 100kA cloud-to-ground lightning flash at a distance of 50m for four different sinusoidal frequencies of current injection with and without the EPR Safety Mat present [1]. The CDEGS software is used extensively in industry and has proven to give a good representation of reality so this modelling should be reasonably accurate.

Field testing was performed at a mine site involving an 11kV substation. The commonly-used Fall-of-Potential (FOP) method [7], which utilises direct current injection into the substation earth grid, was used to assess the effect of the mat on step and touch potentials which were tabulated in the test report [1] for an equivalent 10kA fault to earth. The testing was stated to have been performed using a calibrated current injection test set and associated calibrated tuned voltmeters. Step and touch potential measurements were performed at several locations around the substation with and without the EPR Safety Mat present. The methodology used should give a good indication of the impact on step and touch potentials of using the mat. All test results should of course be assessed against the step and touch potential limits given in the appropriate standards, e.g. [8], [9].

6 Conclusions and Recommendations

The methodology used to test and verify the performance of the EPR Safety Mat developed by LPI was assessed and found to be essentially sound.

The upper insulating surface of the mat was tested to an international standard (IEC 61000:2009) as required for electrical worker safety.

Due to the unique nature of the mat, its step and touch potential mitigation capability was not able to be assessed against a recognised standard. However, the two-part testing strategy using modelling via CDEGS software and field measurements during a Fall-of-Potential current injection

test at an 11kV substation provide a means for good assessment of the impact of the mat on step and touch potentials.

7 References

[1] Lightning Protection International, “EPR Safety Mat – Modelling & Field Testing Summary Report”, 15 April 2014.

[2] IEC 61111:2009, “Live working – Electrical insulating matting”.

[3] ASTM D178-01(2010), “Standard Specification for Rubber Insulating Matting”.

[4] Zenith Industrial Rubber Products, “Test Report - Ref. No. AS/SKC/RM/14-15/72, 22/06/2014” and “Test Report - Ref. No. AS/MM/RM/14-15/187, 01/03/2015”, test reports on rubber sheet to IEC 61111:2009.

[5] IS 15652:2006, “Insulating Mats for Electrical Purposes – Specification”.

[6] http://www.sestech.com/Products/SoftPackages/CDEGS.htm

[7] ENA EG1-2006, “Substation Earthing Guide”.

[8] AS 2067-2008, “Substations and high voltage installations exceeding 1 kV a.c.”.

[9] AS/NZS 3007:2013, “Electrical equipment in mines and quarries – Surface installations and associated processing plant”.