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Report on Resistivity Tests
on

RESLO Ground Enhancement Compound

for

Lightning Protection International Pty Ltd

16 Mertonvale Circuit, Kingston TAS 7050

by

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Report Number 200502 **Date**: 26 October 2005 **Number of pages**: 11

Test Object: **RESLO Ground Enhancement Compound**

Tests Performed by: Rohan Thurstans BE Lightning Protection International Pty Ltd

Signed: __ _____ Date: _26 October 2005___

Tests certified by: David Edwards School of Engineering, University of Tasmania

Signed: __ _____ Date: _26 October 2005___

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The test results given in this report relate only to the tests and equipment described in this report.
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Contents

1 Introduction

RESLO Ground Enhancement Compound is used in earthing systems to reduce soil resistivity adjacent to earth system electrodes so as to reduce the resistance of the earth system.

The resistivity of typical soils varies between 10 Ohm-metre and 1000 Ohm-metre, with higher resistivities occuring with low moisture content and low temperatures.[1]

The resistivity of earth enhancement compounds also varies considerably with moisture content and temperature. Resistivity also varies as the compound goes through various chemical processes as it "sets".

The purpose of this test is to measure the resistivity of a sample of RESLO ground enhancement compound.

The electrical properties of the RESLO were measured by Rohan Thurstans on 20 August 2004, using the equipment and methods described in this report.

This report was prepared by Rohan Thurstans and David Edwards using the data obtained from the tests.

2 Test Equipment

0 to 20 Volt variable voltage DC power supply

Volt meter

Current meter

4 lengths ~1mm^2 wire

4 electrodes

Non-conductive long rectangular container with constant cross section.

[1] *Practical Grounding, Bonding, Shielding and Surge Protection*, Vijayaraghavan, Brown & Barnes, Newnes 2004, pages 62-68

3 Theory

The resistivity of a material can be defined as the electrical resistance between opposite faces of a cube with 1 m sides, measured when a uniformly distributed current is flowing between the two faces.

For a material with resistivity ρ *Ohm – metre*, the resistance R between two faces of area A *metre*^{2} separated by a distance l *metre* is given by $R = \frac{\rho l}{A}$ *Ohms*.

If a resistance measurement is made of a known rectangular volume of material, this formula can be inverted to calculate the resistivity.

In order to measure the resistance, a test current can be injected via the ends of the test volume, and the voltage generated between two inner electrodes measured. This technique is known as the four wire resistance method.

The resistivity can then be calculated as:

$$\rho = \frac{V \bullet D \bullet W}{I \bullet l} \; Ohm - metre$$

where $V =$ measured voltage in Volts

$D =$ depth of container in metres

$W =$ width of container in metres

$I =$ test current in Amps

$l =$ length between voltage electrodes in metres

$\rho =$ resistivity in Ohm-metres

The voltage measuring electrodes should be at a known distance apart with sufficient separation from the current injection electrodes to avoid localised current density variations.

The maximum test current should be restricted to ensure that the compound being tested is not electrically heated, and the time of application of the test current should be limited to avoid electrolysis effects.

4 Test Configuration

Approximate internal dimensions of the polystyrene test container were 250 mm long, 55 mm wide and 40 mm deep. These dimensions were measured with an accuracy of 1%.

The electrodes were fitted into the container such that they could not move when the earth enhancing compound was poured in. The two current electrodes were fitted at either end of the container. The two voltage sense electrodes were placed 150 mm apart, centered between the current electrodes. The distance between the voltage sense electrodes was measured with an accuracy of 3%.

The Variable DC Power Supply was connected in series with the Current Meter and current electrodes. The Voltmeter was connected between the voltage electrodes.

The supply voltage was adjusted to ensure that the maximum test current remained below 1 Amp, and only turned on for brief periods while the voltage was measured.

Readings were taken of current and voltage and time noted. A number of readings were taken at different current levels. The accuracy of these readings was 1%.

The sample was kept undercover. The sample was subject to temperature fluctuations between 10°C and 25°C. Humidity was not recorded, but is known to be reasonably constant at approximately 45%.

Figure 1: Test container filled with RESLO

5 Results

RESLO Resistivity Measurements

Rohan Thurstans 20 August 2004

Parameter	Value	Units	Comments
Width W	0.055	m	Width of Test Container
Depth D	0.04	m	Depth of Test Container
Length L	0.15	m	This is the distance between the voltage electrodes

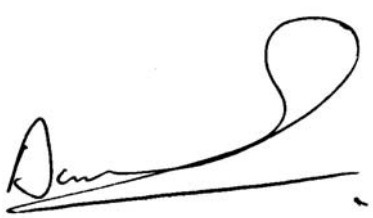
Time	Test Current (mAmps)	Electrode Voltage (Volts)	Resistivity (Ohm-m)	Comments
11:30				RESLO poured into container
12:00	300	8.24	0.40	
12:00	150	3.72	0.36	
12:00	100	2.35	0.34	
12:00	50	0.98	0.29	
12:00	25	0.28	0.16	
12:00	10	0.13	0.20	
15:00	100	3.04	0.45	
21:30	300	10.42	0.51	fully set
21:30	200	6.96	0.51	fully set
21:30	100	3.60	0.53	fully set
21:30	25	0.98	0.57	fully set
		Average	0.53	Average of fully set values only

Resistivity = Volts x Depth x Width / (Amps x Length)

6 Conclusions

RESLO ground enhancement compound was found to have an electrical resistivity of 0.5 Ohm-metre.

This is between one and three orders of magnitude lower than the resistivity of typical soils, implying that when used as directed, this compound will reduce soil resistivity.



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7 Appendix A: RESLO Technical Data Sheet

- Technical Data Sheet: LPI RESLO
    - Best solution for standard soil conditions
    - Mix with water and pour onto required area
    - Does not wash away
    - Suitable for applications where driving ground rods may be difficult
    - Comes in easy to handle 10kg bags

LPI® RESLO

- **Product Description**

The requirement of a good earth resistance is extremely important with the installation of any earthing system.

LPI's RESLO provides the ability to dramatically reduce soil resistivity even in soils with average electrical conductivity.

RESLO is comprised of specifically selected compounds, which possess excellent electrical conductivity. When RESLO is mixed with water and poured on the earthing system and surrounding soil the powder and water react to form a hardened mass within your earthing system. RESLO will not wash away under seasonal conditions and therefore provides a permanent presence in working to improve and maintain the integrity of your earthing system. Given that RESLO does not wash away the requirement to re-treat the soil as is the case with other enhancing compounds is eliminated.

RESLO is supplied in multiples of 10kg-packaged bags to suit your site application. These packaged bags have full installation and handling instructions and combine a plastic handle and HDPE plastic inner for ease and safety of handling.

- **Product Application**

Given that all earthing systems are installed in varying soil types and conditions, it must be understood that the application results of RESLO will also be dependant on these site-specific conditions. For a typical trench installation, one 10 Kg kit of RESLO will achieve desired earth resistance levels in combination with appropriate conductors for a trench covering 2.5m in length x 300mm in width and a depth of 500mm to 1000mm.

All earthing systems are typically required to achieve a Ground DC Resistance of < 10 Ohms and impedance of < 30 Ohms as outlined in most standards.

If installing either a radial earthing system or grid type earthing system it is recommended that all earthing conductors be installed at a depth of between 500mm and 750mm (recommended) with a maximum depth of 1000mm. In order to further assist in improving the earth resistance of the system, it is recommended that excavated soil of poor quality (Rocky) be replaced with soil of a good quality prior to replacing the earthing system with all excavated soil.

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RECOMMENDED BAGS OF RESLO-10 REQUIRED FOR BACKFILLING TYPICAL TRENCH INSTALLATIONS

Width of Trench (mm)	Length of Trench 2.5m	Length of Trench 5m
300 mm	1	2

For trench dimensions outside of the given specifications please contact LPI or an authorized distributor for further advice.

RECOMMENDED BAGS OF RESLO-10 REQUIRED FOR BACKFILLING GROUND ROD INSTALLATION

Dia. of Hole (mm)	Depth of Hole (mm) 1800mm	Depth of Hole (mm) 2400mm	Depth of Hole (mm) 3000mm
75mm	1	1	1
125mm	2	2	3
175mm	3	4	5

For augured hole dimensions outside of the given specifications please contact LPI or an authorised distributor for further advice.

- *"**LPI Endorsed Product**" – The symbol of assurance of quality and performance.*
- *LPI has a policy of continuing product development. Therefore, the above specifications are subject to change without notice.*

LPI® - Innovative Lightning and Surge Protection Solutions

Direct Strike Protection

Surge & Transient Protection for Power, Data, Communications and RF lines

Grounding Products & Solutions

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8 Appendix B: RESLO Installation Instructions

LPI® RESLO-10 INSTALLATION INSTRUCTIONS

TRENCH INSTALLATION

The application of RESLO-10 (10kg) to a typical earthing system installed in a trench, which consists of rods, tapes or cables, involves the following steps.

1. Dig a trench to the recommended dimensions as detailed in the attached drawings.
2. Saturate the entire area by dousing with water.
3. Place all rods, tapes or cables into position as required.
4. Mix 5kg of RESLO-10 with 5 litres of water adding only a little at a time at the start to ensure a paste like consistency then gradually making the mix thinner with the addition of small amounts of water until the entire 5 litres is added (note avoid large lumps in the mix that become hard to dissolve by only adding a minium of water until a smooth paste is created after which water can be added in larger portions.) The mixing of RESLO-10 and water is best done in a cement mixer or in a wheelbarrow or large bin with the aid of a mixing rod or mechanical agitator to correctly mix the water and the RESLO-10.
5. Immediately pour mix directly onto 1.25m of earthing system.
6. Repeat steps 4 & 5 for every additional 1.25m length of earthing until entire trench has been applied with RESLO.
7. Backfill the remainder of the trench with the excavated soil.

Note: If the excavated soil is of poor quality eg. clay rock or shale, it should not be used and garden loam or sand should be used as a replacement.

RECOMMENDED BAGS OF RESLO-10 REQUIRED FOR BACK-FILLING TYPICAL TRENCH INSTALLATIONS

Width of Trench (mm)	Length of Trench 2.5m	Length of Trench 5m
300 mm	1	2

For trench dimensions outside of the given specifications please contact LPI or an authorised distributor for further advice.

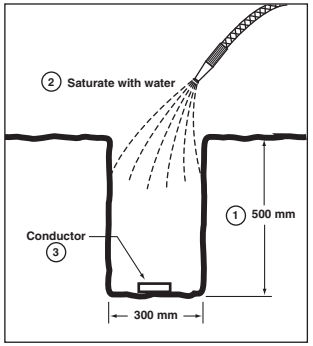

Figure 1

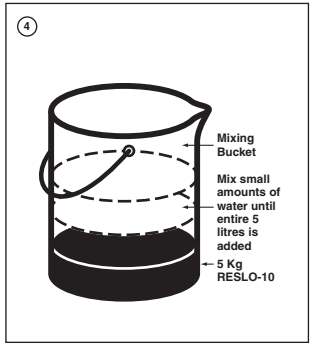

Figure 2

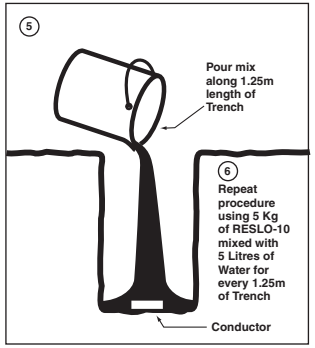

Figure 3

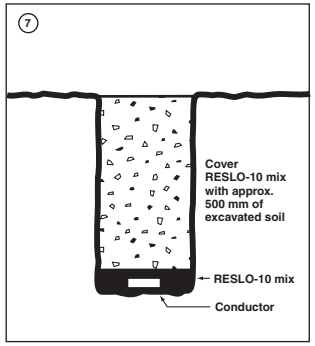

Figure 4

EARTH ROD INSTALLATION

The application of RESLO-10 (10 Kg) for a driven earth rod involves the following steps.

1. Drill or auger a 75mm (approx.) diameter hole to a depth of 150mm less than the length of the rod to be installed.
2. Saturate the hole by dousing with water.
3. Place the earth rod into a central position in the hole and drive the rod 300mm if possible into the soil at the bottom of the hole. The top section of the earth rod should now be approximately 150mm below the lip of the hole. If required make all EXOWELD connections to the earth rod at this time.
4. Mix 5kg of RESLO-10 with 5 litres of water adding only a little at a time at the start to ensure a paste like consistency then gradually making the mix thinner with the addition of small amounts of water until the entire 5 litres is added (note avoid large lumps in the mix that become hard to dissolve by only adding a minium of water until a smooth paste is created after which water can be added in larger portions.) The mixing of RESLO-10 and water is best done in a cement mixer or in a wheelbarrow or large bin with the aid of a mixing rod or mechanical agitator to correctly mix the water and the RESLO-10.
5. Immediately pour mix directly into augured hole.
6. Repeat steps 4 and 5 in accordance with recommended number of applications of RESLO-10 as per the attached table.
7. Backfill the remainder of the hole with the excavated soil.

RECOMMENDED BAGS OF RESLO-10 REQUIRED FOR BACKFILLING EARTH ROD INSTALLATION

Dia. of Hole (mm)	Depth of Hole (mm) 1800mm	Depth of Hole (mm) 2400mm	Depth of Hole (mm) 3000mm
75mm	1	1	1
125mm	2	2	3
175mm	3	4	5

For augured hole dimensions outside of the given specifications please contact LPI or an authorised distributor for further advice.

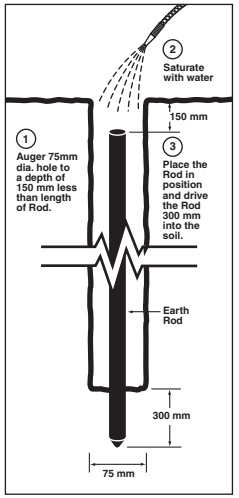

Figure 1

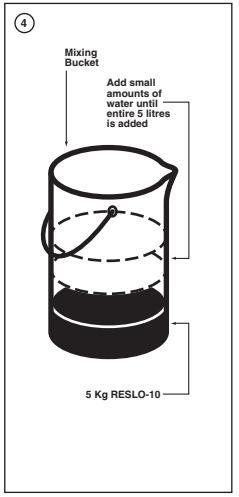

Figure 2

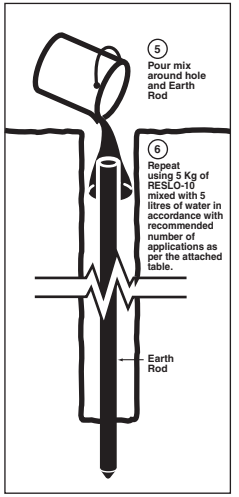

Figure 3

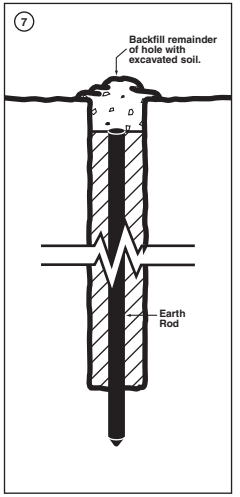

Figure 4

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