



Results obtained during tests performed on clamps, conical coupling muffers and driving heads

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PART A. Report on results of the tests performed on clamps

Identification of the tested sample: GEN-58-I for grounding rod 5/8"

1.- Sample preparation

The connector was fitted to an earth electrode approx 250 mm with minimum thickness 250 μm and a circular multicore cable 2*25². Testing has been carrying out on three identical samples.

2.- Torsion test

According to Teconex specifications a torque of 25 Nm was applied to the screw.

Acceptance criteria: No damage to the clamp or to the conductor or the electrode takes place

RESULT: COMPLIES

3.- Initial electrical resistance

Remarks: the tests have been carried out in the Department of Electrical Engineering of the University of Oviedo.

Four-wire measurements were carried out using a system power supply, a six-digit voltmeter and a digital thermometer.

According to 7.2 from KEMA-standard K83C, the resistance of the connector was measured between points on the rod and the earth conductor with are 50 mm at either side of the connector, and the value was recorded.

Figure 1 and 2 show the assembly.

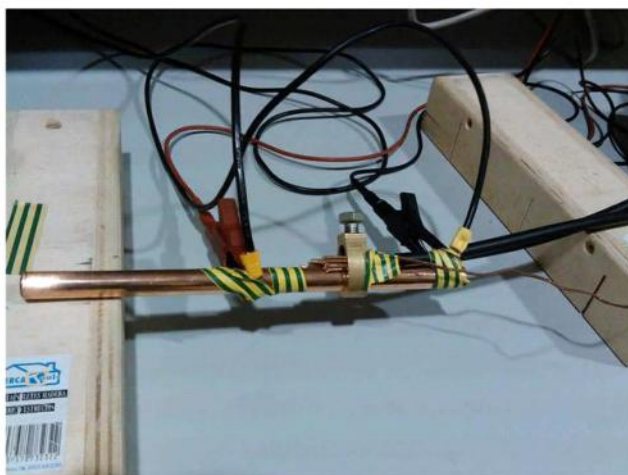


Figure 1



Figure 2

Experiments at two different intensities were carried out. The following table shows the results and the calculated resistance at 20°C taking into account the effect of the temperature.

Sample	Intensity	T (°C)	V (mV)	R _{20°C} (mΩ)
1	30 A	27.7	1.289	0.0417
1	25 A	27.7	1.076	0.0417
2	30 A	27.5	1.291	0.0417
2	25 A	27.5	1.065	0.0413
3	30 A	27.1	1.285	0.0416
3	25 A	27.1	1.080	0.0419

4.- Corrosion test

Salt spray testing according to ASTM B117 has been carried out for 500 hours and the results are tabulated as follows. The collected solution in each vessel (SV) is also registered. The test began on 10th November.

Time	Sample 1	Sample 2	Sample 3	SV (ml/h)
24 h	OK	OK	OK	1.02
48 h	OK	OK	OK	1.98
72 h	OK	OK	OK	1.01
96 h	OK	OK	OK	1.06
120 h	OK	OK	OK	1.12
144 h	OK	OK	OK	1.12
168 h	OK	OK	OK	1.12
192 h	OK	OK	OK	1.12
216 h	OK	OK	OK	1.38
240 h	OK	OK	OK	1.19
264 h	OK	OK	OK	1.08
288 h	OK	OK	OK	1.16
312 h	OK	OK	OK	1.13
336 h	OK	OK	OK	1.13

Time	Sample 1	Sample 2	Sample 3	SV (ml/h)
360 h	OK	OK	OK	1.13
384 h	OK	OK	OK	1.10
408 h	OK	OK	OK	1.38
432 h	OK	OK	OK	1.42
456 h	OK	OK	OK	1.10
480 h	OK	OK	OK	1.12
504 h	OK	OK	OK	1.19

Acceptance criteria: No iron corrosion takes place.

Note: The ends of the rod must not take into account for being bare steel. Copper oxides are accepted.

RESULT: COMPLIES (see photographs at the beginning and after 504 hours)



Figure 3. Sample N°1 t=0



Figure 4. Sample N°2 t=0



Figure 5. Sample N°3 t=0



Figure 6. Sample N°1 after 504 h



Figure 7. Sample N°2 after 504 h



Figure 8. Sample N°3 after 504 h

5.- Final electrical resistance

After corrosion test, the electrical resistance was measured again. The results are shown as below:

Sample	I (A)	T (°C)	V (mV)	R _{20°C} (mΩ)
1	30	20.2	1.337	0.0445
1	25	20.2	1.110	0.0443
2	30	20.3	1.340	0.0446
2	25	20.3	1.112	0.0444
3	30	20.5	1.335	0.0444
3	25	20.5	1.108	0.0442

Acceptance criteria: The electrical resistance must be less than 120% its initial value.

RESULT: COMPLIES

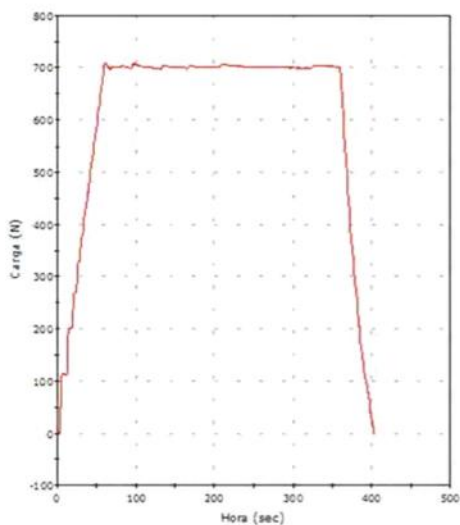


Figure 10

Acceptance criteria: No rupture or damage of the connection occurs.

RESULT: COMPLIES

PART B. Report on results of the tests performed on conical coupling muffs

Identification of the tested sample: MA-14-P for grounding rod 5/8"

1.- Sample preparation

Two electrodes approx 250 mm long and one conical coupler were assembled in accordance with the common practice. Testing has been carrying out on three identical samples.

2.- Initial electrical resistance

Remarks: the tests have been carried out in the Department of Electrical Engineering of the University of Oviedo.

Four-wire measurements were carried out using a system power supply, a six-digit voltmeter and a digital thermometer.

According to 5.5 from KEMA-standard K83C, the resistance of the joint was measured between points 50 mm at either side of coupler and the values were recorded.

Figure 11 and 12 show the assembly.

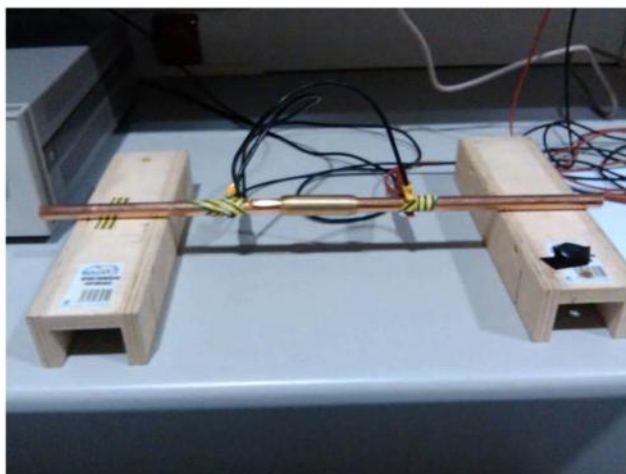


Figure 11

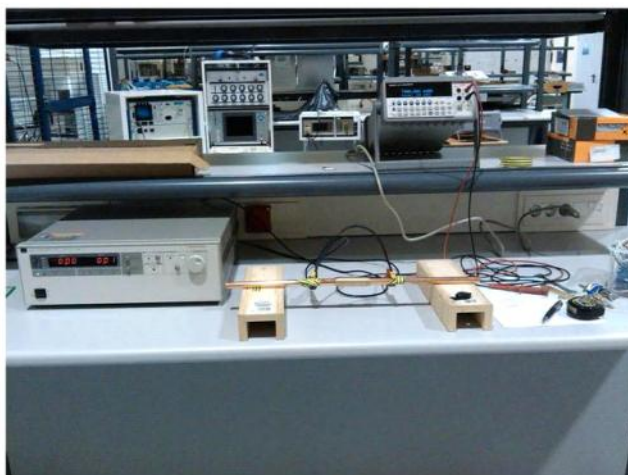


Figure 12

The following table shows the results and the calculated resistance at 20°C.

Sample	Intensity	T (°C)	V (mV)	R _{20°C} (mΩ)
1	30 A	24.8	3.083	0.100
1	25 A	24.8	2.572	0.100
2	30 A	25.5	3.232	0.105
2	25 A	25.5	2.650	0.104
3	30 A	25.0	3.105	0.101
3	25 A	25.0	2.590	0.102

3.- Corrosion test

Salt spray testing according to ASTM B117 has been carried out for 500 hours and the results are tabulated as follows. The collected solution in each vessel (SV) is also registered. The test began on 10th November.

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Time (h)	Sample 1	Sample 2	Sample 3	SV (ml/h)
24 h	OK	OK	OK	1.02
48 h	OK	OK	OK	1.98
72 h	OK	OK	OK	1.01
96 h	OK	OK	OK	1.06
120 h	OK	OK	OK	1.12
144 h	OK	OK	OK	1.12
168 h	OK	OK	OK	1.12
192 h	OK	OK	OK	1.12
216 h	OK	OK	OK	1.38
240 h	OK	OK	OK	1.19
264 h	OK	OK	OK	1.08
288 h	OK	OK	OK	1.16
312 h	OK	OK	OK	1.13
336 h	OK	OK	OK	1.13
360 h	OK	OK	OK	1.13
384 h	OK	OK	OK	1.10
408 h	OK	OK	OK	1.38
432 h	OK	OK	OK	1.42
456 h	OK	OK	OK	1.10
480 h	OK	OK	OK	1.12
504 h	OK	OK	OK	1.19

Acceptance criteria: No iron corrosion takes place.

Note: The ends of the rod must not take into account for being bare steel. Copper oxides are accepted.

RESULT: COMPLIES (see photographs at the beginning and after 504 hours)

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Figure 13. Sample 1 $t=0$



Figure 14. Sample 2 $t=0$



Figure 15. Sample 3 t=0



Figure 16. Sample 1 after 504 h



Figure 17. Sample 1 after 504 h



Figure 18. Sample 2 after 504 h



Figure 19. Sample 2 after 504 h



Figure 20. Sample 3 after 504 h



Figure 21. Sample 3 after 504 h

4.- Final electrical resistance

After corrosion test, the electrical resistance was measured again. Results are shown as below:

Sample	I (A)	T (°C)	V (mV)	R _{20°C} (mΩ)
1	30	20.4	1.811	0.060
1	25	20.3	1.509	0.060
2	30	20.2	1.674	0.056
2	25	20.5	1.400	0.056
3	30	21.0	1.750	0.058
3	25	21.2	1.420	0.057

Acceptance criteria: The electrical resistance must be less than 120% its initial value.

RESULT: COMPLIES

5.- Traction

The sample was stressed on a suitable tensile test machine. At a tensile stress below 2500 N, the connection began to loosen and the test had to finish. The graphic and the assembly are shown as follows.

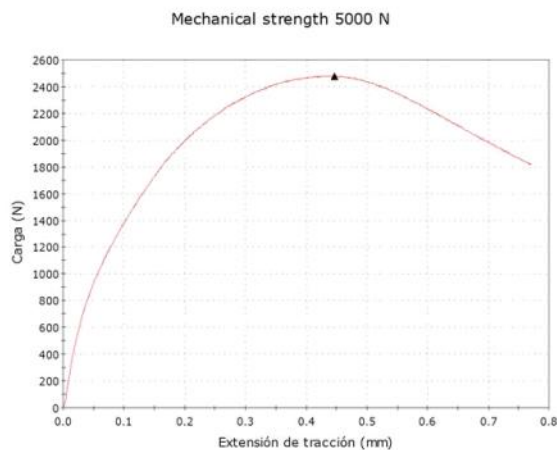


Figure 22



Figure 23

6.- Impact

The test according to 5.6 from KEMA 83 was not carried out, although the sample was subjected to a pressure of 1000 kg in the assembly of traction test without rupture of the connection.

PART C. Report on results of the tests performed on driving heads

Identification of the tested sample: S15

1.- Impact

Three samples suffered a impact of 10 kg falling from a height of 1.5 m.



Figure 24



Figure 25



Figure 26



Material de puesta a tierra – Estañado – Plateado – Cincado
electrolítico



Acceptance criteria: No damage of beating head after test

RESULT: COMPLIES

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