UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA" DIPARTIMENTO DI INGEGNERIA ELETTRICA

Via Eudossiana, 18 - 00184 Roma – Tel. (06) 44585534 - Fax (06) 4883235

Prepared
EL/ENG Francesco Galli, EL/ENG/Paolo Sciavartini
Approved
EL/ENG Francesco Galli,

Type test according to IEC 60502-2:2005 On M5AX2B cable 12/20 (24) kV 3x240 mm² AL/CuT/STA/PVC

1 INTRODUCTION

Type test according to IEC 60502-2 (second edition 2005-03) has been performed by University of Rome – Electrical engineering department, , on the cable 12/20 (24) kV 3x240 mm² AL manufactured by medcables/ teffahta Lebanon.

2 SUMMARY

The cable passed all tests Positively without remarks.

UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA" DIPARTIMENTO DI INGEGNERIA ELETTRICA

Via Eudossiana, 18 - 00184 Roma – Tel. (06) 44585534 - Fax (06) 4883235

3 TABLE OF CONTENTS

4 CABLE SPECIFICATION

Type:	MEDCABLES 24 kV 3x240/35
Rated voltage:	12/20 (24) kV Conductor: 3x240 mm². Al, round.
Conductor screen:	Extruded semi conducting compound.
Insulation:	XLPE
Insulation screen:	Extruded semi conducting compound. Strippable.
Shield:	32 mm². Woven bands of tinned copper threads.
Armour:	Steel Tape Armour.
Sheath:	Red PVC
Construction no:	M5AX2B

5 ELECTRICAL TESTS

5.1 Partial discharge test at ambient temperature before bending test

	Core 1	Core 2	Core 3	Requirements
Noise level, pC	0,4	0,4	0,4	Not specified
Discharge level at 21 kV, pC	1,7	1,4	1,0	≤ 5

5.2 Bending test

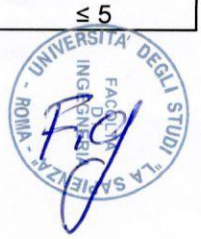
According to IEC 60502-2 section 18.1.3.

The sample was bent around a cylinder with a diameter of 1100 mm, at ambient temperature for one complete turn then unwound. The cable was then rotated 180° longitudinally and then the process was repeated. This cycle of operation was carried out totally three times.

5.3 Partial discharge test after bending

According to IEC 60502-2 section 18.1.4.

	Core 1	Core 2	Core 3	Requirements
Noise level, pC	0,5	0,5	0,5	Not specified
Discharge level at 21 kV, pC	0,8	0,7	0,7	≤ 5

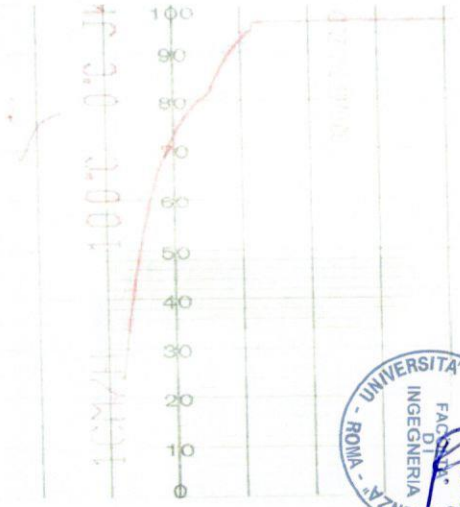


5.4 Tan delta measurement

According to IEC 60502-2 section 18.1.5.

The sample was heated with current through the conductor, until the temperature stabilized at 95-100 °C, see figure 1.

Figure 1



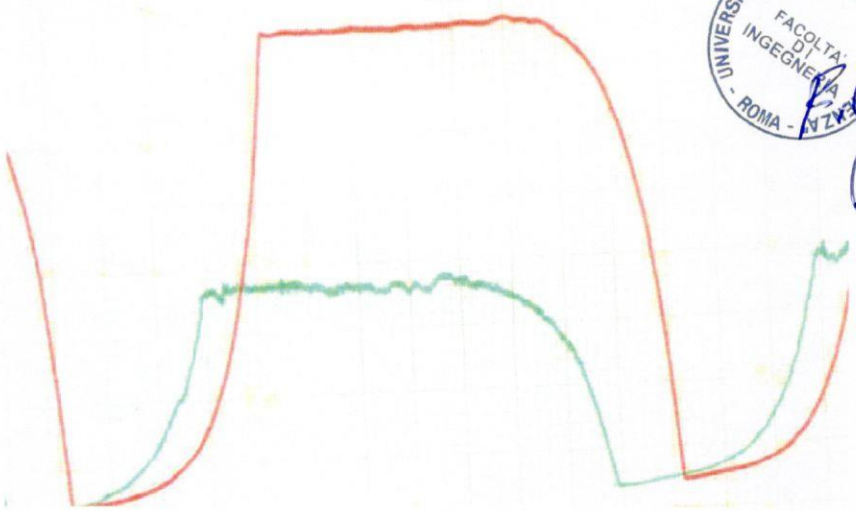
	Core 1	Core 2	Core 3	Requirements
Loss factor at ambiat temp, measurred at 2 kV	$3,3 \times 10^{-4}$	$3,6 \times 10^{-4}$	$3,5 \times 10^{-4}$	$< 40 \times 10^{-4}$
Loss factor at 95-100°C, measurred at 2 kV	$6,4 \times 10^{-4}$	$6,4 \times 10^{-4}$	$7,9 \times 10^{-4}$	$< 40 \times 10^{-4}$

5.5 Heating cycle test

According to IEC 60502-2 section 18.1.6.

The sample was heated with current through the conductor until the temperature stabilized at 95-100 °C. The sample was then heated for 8 h followed by 4 h of natural cooling. This heat cycle was performed 20 times, see figure 2 below.

Figure 2



After the heating cycle voltage test a partial discharge test at ambient temperature was performed.

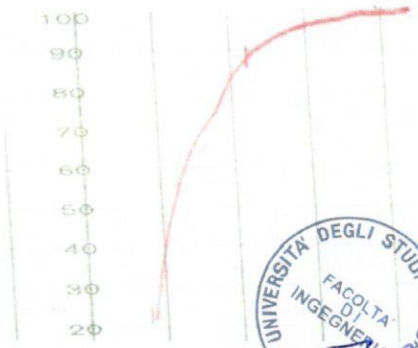
	Core 1	Core 2	Core 3	Requirements
Noise level, pC	0,2	0,2	0,2	Not specified
Discharge level at 21 kV, pC	0,4	0,7	0,6	≤ 5

5.6 Impulse voltage test

According to IEC 60502-2 section 18.1.7.

The test was performed at a conductor temperature of 95-100 °C, see figure 3. The cable withstood 10 positive and 10 negative impulses of 125 kV, see appendix.

Figure 3



5.7 AC voltage test after impulse voltage test

According to IEC 60502-2 section 18.1.7.

42 kV AC was applied between the conductor and the metallic screen for 15 minutes. No breakdown occurred.

5.8 Voltage test for 4 h

According to IEC 60502-2 section 18.1.8.

48 kV AC was applied between the conductor and the metallic screen for 4 hours. No breakdown occurred.

5.9 Examination

The cable was examined after all tests and nothing notable was found

5.10 Resistivity of semi-conducting screens

According to IEC 60502-2 section 18.1.9.

5.10.1 Conductor screen

	Core 1	Core 2	Core 3	Requirements
Resistivity before ageing, Ωm	107,6	136,7	110,5	≤ 500
Resistivity after ageing, Ωm	142,9	113,0	116,3	≤ 500

5.10.2 Insulation screen

	Core 1	Core 2	Core 3	Requirements
Resistivity before ageing, Ωm	9,0	9,5	9,7	≤ 1000
Resistivity after ageing, Ωm	1,8	1,9	1,9	≤ 1000

6 NON-ELECTRICAL TESTS

6.1 Thickness of the insulation

According to IEC 60502-2 section 19.1.

	Core 1	Core 2	Core 3	Requirements
Average thickness, mm	5,55	5,53	5,51	≥ 5,45
Minimum thickness (t_{min}), mm	5,50	5,49	5,43	≥ 4,85
Maximum thickness (t_{max}), mm	5,59	5,56	5,53	Not specified
$(t_{max}-t_{min})/t_{max}$	0,09	0,07	0,10	≤ 0,15

6.2 Thickness of the non-metallic sheath

According to IEC 60502-2 section 19.2.

	Measured value	Requirements
Average thickness, mm	2,32	Not specified
Minimum thickness, mm	2,43	≥ 2,0
Maximum thickness, mm	2,76	Not specified

6.3 Mechanical properties of the insulation

According to IEC 60502-2 section 19.3.

6.3.1 Before ageing

	Core 1	Core 2	Core 3	Requirements
Tensile strength, MPa	23,9	23,3	23,6	≥ 12,5
Elongation at break, %	472	496	495	≥ 200

6.3.2 After ageing

	Core 1	Core 2	Core 3	Requirements
Tensile strength, MPa	23,2	23,0	25,0	Not specified
Variation of tensile strength, %	- 3	- 1	5,6	± 25
Elongation at break, %	540	536	529	Not specified
Variation of elongation at break, %	14	8	7	± 25

6.4 Mechanical properties of the non-metallic sheath

According to IEC 60502-2 section 19.4.

6.4.1 Before ageing

	Measured value	Requirements
Tensile strength, MPa	30,5	≥ 12,5
Elongation at break, %	813	≥ 300

6.4.2 After ageing

	Measured value	Requirements
Tensile strength, MPa	23,1	Not specified
Variation of tensile strength, %	- 24	Not specified
Elongation at break, %	744	≥ 300
Variation of elongation at break, %	- 8	Not specified

6.5 Additional ageing test on pieces of the complete cable

According to IEC60502-2 section 19.5.

6.5.1 Insulation

6.5.1.1 Before ageing

	Core 1	Core 2	Core 3	Requirements
Tensile strength, MPa	23,9	23,3	23,6	≥ 12,5
Elongation at break, %	472	496	495	≥ 200

6.5.1.2 After ageing

	Core 1	Core 2	Core 3	Requirements
Tensile strength, MPa	25,0	25,1	25,7	Not specified
Variation of tensile strength, %	4,5	8	9	± 25
Elongation at break, %	489	494	498	Not Specified
Variation of elongation at break, %	3,5	- 0,3	0,6	± 25

6.5.2 Sheath

6.5.2.1 Before ageing

	Measured value	Requirements
Tensile strength, MPa	30,5	≥ 12,5
Elongation at break, %	813	≥ 300

6.5.2.2 After ageing

	Measured value	Requirements
Tensile strength, MPa	28,4	Not specified
Variation of tensile strength, %	- 7	Not specified
Elongation at break, %	825	≥ 300
Variation of elongation at break, %	1,5	Not specified

6.6 Pressure test at high temperature on the non-metallic sheath

According to IEC 60520-2 section 19.7.

	Measured value	Requirements
Depth of indentation, %	8	≤ 50

6.7 Hot set test on the insulation

According to IEC 60502-2 section 19.11.

	Core 1	Core 2	Core 3	Requirements
Elongation under load, %	70	70	50	≤ 175
Residual elongation, %	0	0	0	≤ 15

6.8 Water absorption test on the insulation

According to IEC 60502-2 section 19.13.

	Core 1	Core 2	Core 3	Requirements
Water absorption, mg/cm²	0	0,04	0,01	≤ 1

6.9 Carbon black content of the black PVC-oversheath

According to IEC 60502-2 section 19.15.

	Measured value	Requirements
Carbon black content, %	2,0-3,0*	1,5-3,0

*Value from manufacturer

6.10 Shrinkage test for the XLPE-insulation

According to IEC 60502-2 section 19.16.

	Core 1	Core 2	Core 3	Requirements
Shrinkage, %	1,0	1,25	1,25	≤ 4

6.11 Shrinkage test for the PVC-oversheath

According to IEC 60520-2 section 19.20.

Due to that the cable sample was bent, the shrinkage was measured on the inside as well as on the outside of the cable sample.

	Measured value	Requirements
Shrinkage on the inside of the cable sample, %	0,2	≤ 3
Shrinkage on the outside of the cable sample, %	0,8	≤ 3

6.12 Strippability test for the insulation screen

According to IEC 60502-2 section 19.21.

6.12.1 Before ageing

	Core 1	Core 2	Core 3	Requirements
Adhesion of the insulation screen to the insulation, N	6,9 - 7,4	7,4 – 7,9	6,6 – 7,4	4-45

6.12.2 After ageing

	Core 1	Core 2	Core 3	Requirements
Adhesion of the insulation screen to the insulation, N	7,3 – 7,8	7,2 – 7,8	8,2 – 8,6	4-45

6.13 Water penetration test of the conductors

According to IEC 60502-2 section 19.22.

F.3 Requirements

During the period of testing no water shall emerge from the ends of the test piece.

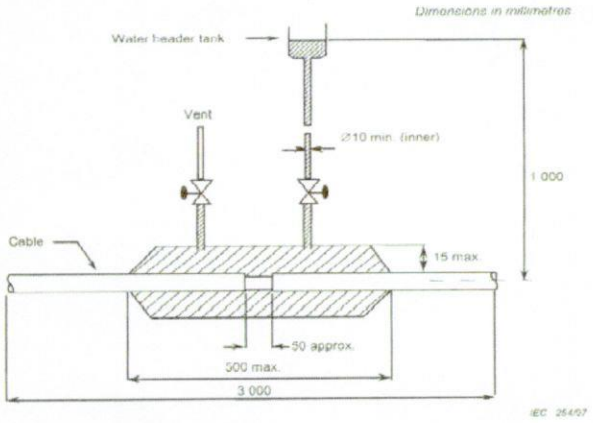


Figure F.1 – Schematic diagram of apparatus for water penetration test

The test assembly was mounted in such a way that the relevant interstices were readily exposed to the water. Water was filled into the assembly so that the opening in the test piece was subjected to water with a pressure head of 1 meter. The cable was kept so for 24 hours.

Subsequently the test piece was subjected to 10 complete heating cycles. The heating period was 8 hours followed by 4 hours of natural cooling.

The conductor temperature was raised to a value of 95°C.

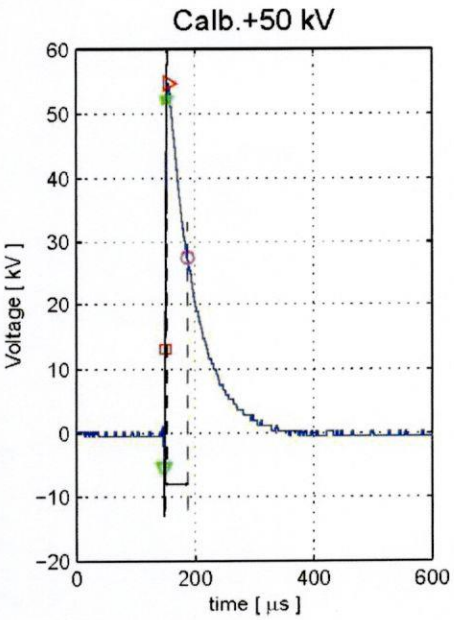
During the test no water is allowed to emerge from the ends of the cable. After 10 cycles no water had emerged from the ends of the test cable.

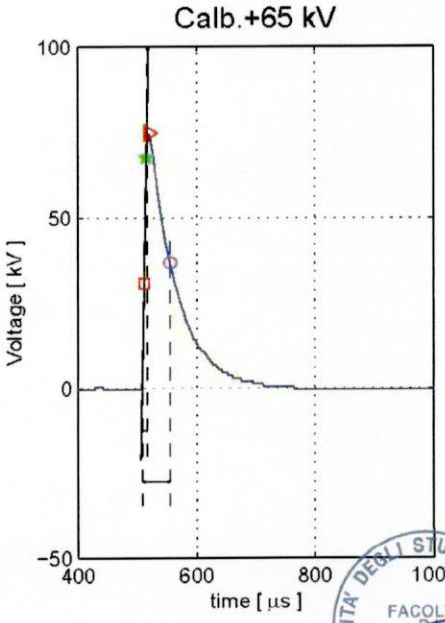
7 USED INSTRUMENTS

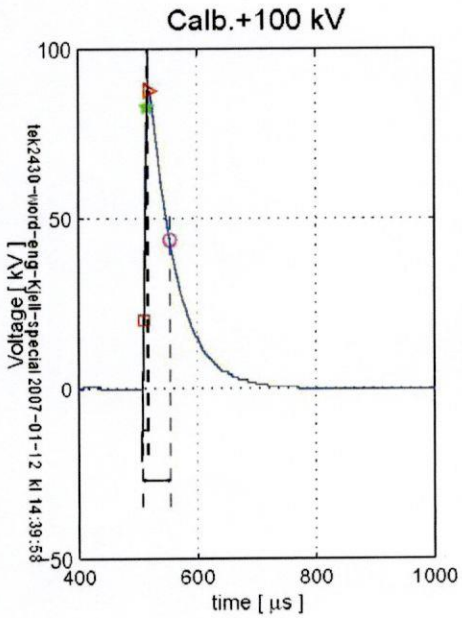
No	Instrument	
1	Automatic measure machine, KSM	
2	Die Elastocon EP 04/ISO 37-2	
3	Equipment for pressure test	
4	Equipment for pressure test	
5	Equipment for pressure test	
6	Fiber Thermometer	
7	Heating chamber, Elastocon EB04	
8	Heating chamber, Elastocon EB10	
9	Heating chamber, Elastocon EB10	
10	Heating chamber, Elastocon EB10	
11	Heating chamber, Elastocon EB10	
12	Heating chamber, Elastocon EB10	
13	Heating chamber, Memmert UE 500	
14	Hounsfield test equipment	
15	HV Series Resonant Test System	
16	Measure ruler	
17	Measure ruler	
18	Measure tape, T.A. Ljungberg 2m	
19	Micro ohmmeter, Tettex AG	
20	Micrometer, Mitutoyo 0-25 mm	
21	Miniature Discharge Simulator	
22	Oscilloscope	
23	Peak Voltmeter	
24	Precisa weighing machine	
25	Pulse Discrimination unit	
26	Recorder	
27	Recorder	

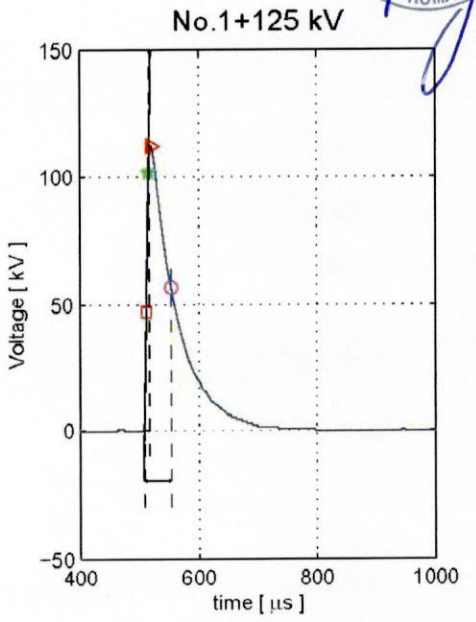
	Instrument	
28	Schering Bridge	
29	Set of weights for pressure test	
30	Set of weights for pressure test	
31	Set of weights for pressure test	
32	Set of weights to hot set	
33	Sliding Divider	
34	Timer	
35	Timer	
36	Vacuum drying oven, Binder VD53	
37	Voltage Divider	

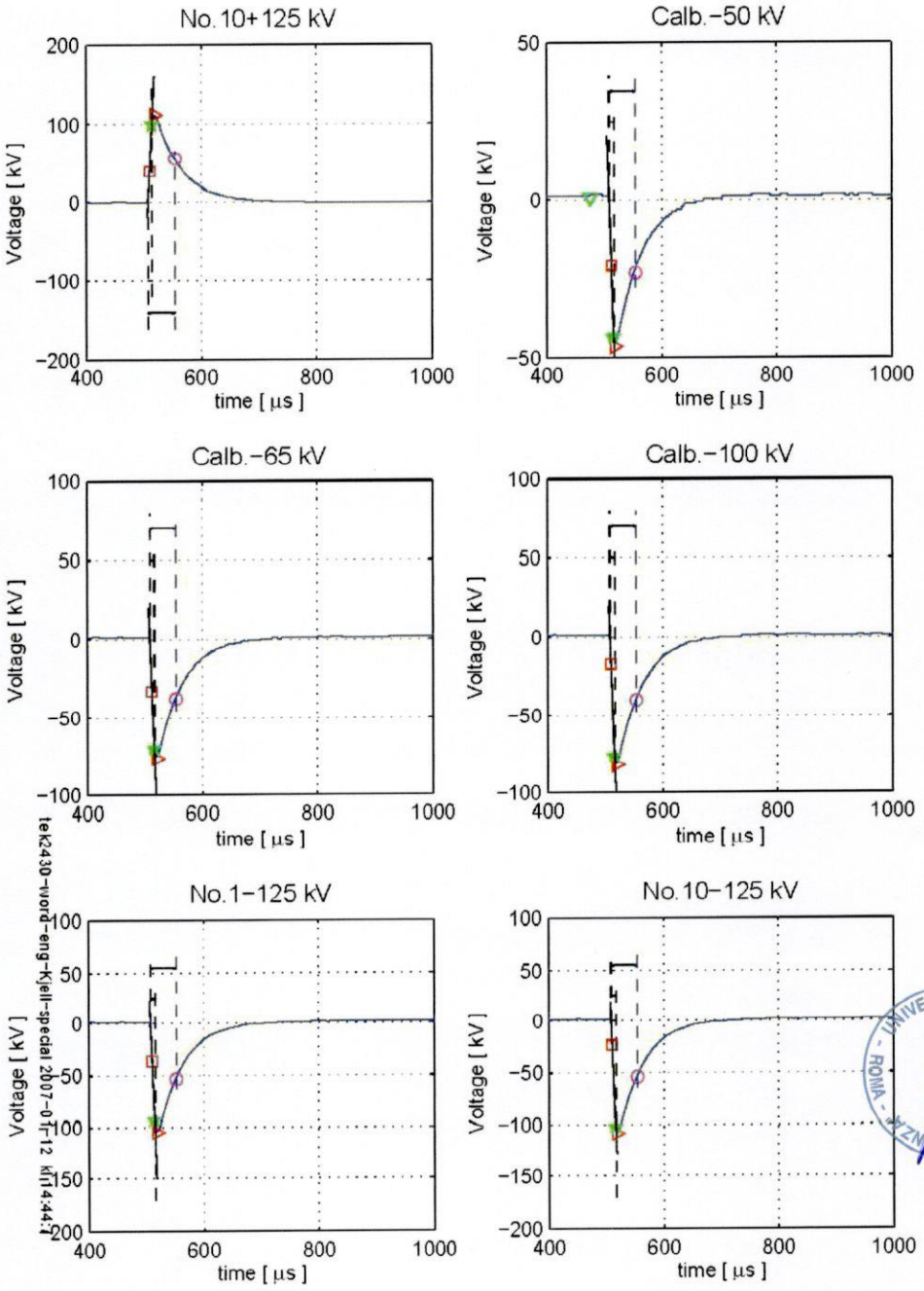
8 APPENDIX

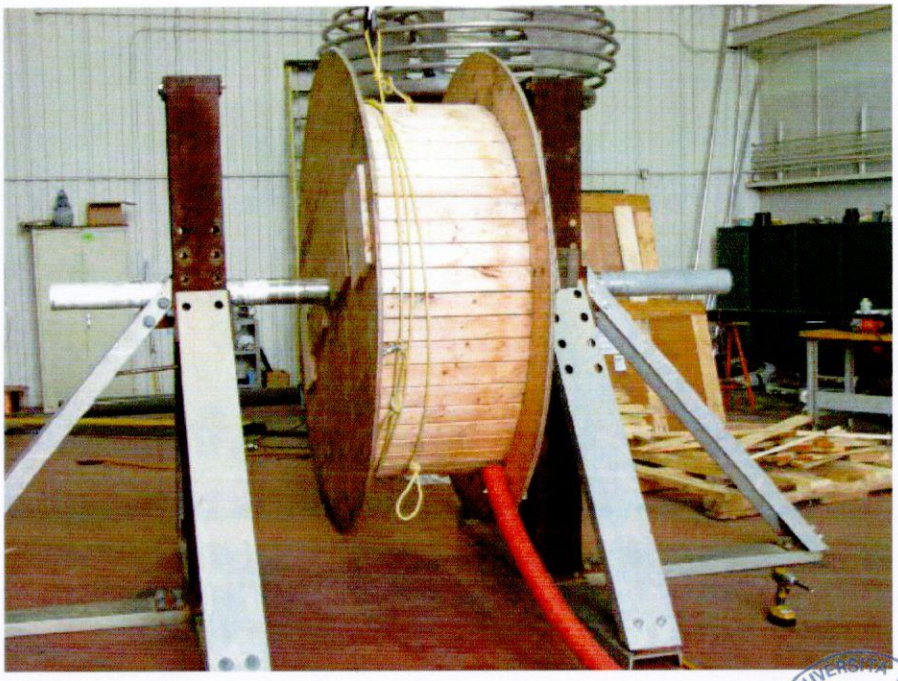




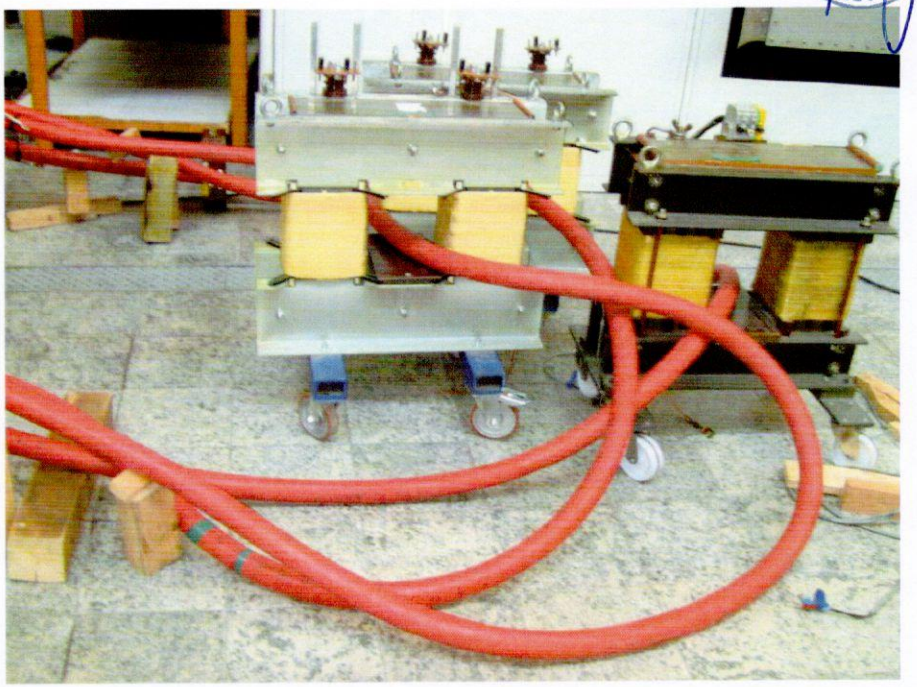





No.10+125 kV
Calb.−50 kV
Calb.−65 kV
Calb.−100 kV
No.1−125 kV
No.10−125 kV
Voltage [kV]
time [µs]
tek430-word-eng-kjell-special 2007-01-12 kl 14:44:1



Setup of Bending Test

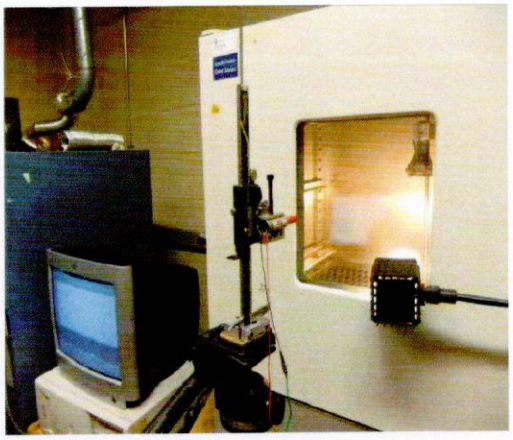


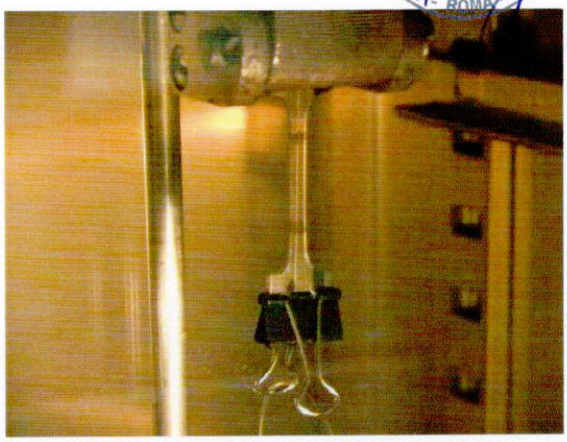
During Heat cycles Tests

UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA" DIPARTIMENTO DI INGEGNERIA ELETTRICA

Via Eudossiana, 18 - 00184 Roma – Tel. (06) 44585534 - Fax (06) 4883235

Water Penetration Test





Hot Set Test

UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA" DIPARTIMENTO DI INGEGNERIA ELETTRICA

Via Eudossiana, 18 - 00184 Roma – Tel. (06) 44585534 - Fax (06) 4883235

شركة البحر المتوسط للكابلات ش.م.ل.

DATA DESIGNE + DATA ELECTRIQUE		
Manufactury by		Medcables / Teffahta
Country		Lebanon
Testing		In our laboratory

AL / S.C./ XLPE / S.C./ CuT / P.V.C./STA/P.V.C

Applicable standard		IEC 60502 - 2
Medium voltage		**M5AX2B**
Section	**mm²**	**3 x 240**
Rated voltage		12/20 kv (24) kv
Conductor	mm²	240
Conductor screen		Semi conductor extruded bonded
Thichness	mm	0.5
Insulation	mm	XLPE cross linking extruded
Thickness	mm	5.5
Insulation screen		S.C extruded STRIPIPLE
Thickness	mm	0.5
Screend cross section 32	mm²	(40 x 0.1) 2 copper tape
Φ Assemblage	mm	77.44
Iner sheating thichness	mm	2.15 P.V.C.
galvanized steel tape		(50 x 0.5) 2 steel tape
Overal diameter ± 8 %	mm	89.2
Approx weight	kg/km	7720
Lineaire resistance	Ω / km	0.125
Outer sheat		P.V.C.
Thickness	mm	3.9
Color		RED
Marking		Ink jet printing

UNIVERSITA' DEGLI STUDI "LA SAPIENZA" FACOLTA' DI INGEGNERIA ROMA

Mediterranean cables company Bldg. Tefehta - Zahrani , lebanon
Tel : +961 7 420 840 / 850 Fax : +961 7 420 830
medcables@hotmail.com

UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA" DIPARTIMENTO DI INGEGNERIA ELETTRICA
Via Eudossiana, 18 - 00184 Roma – Tel. (06) 44585534 - Fax (06) 4883235

M5AX2B 3x240mm² AL

Electrical data		
Lineaire resistance at 20C°	Ω / km	0.125
at 90C °	Ω / km	0.159
Reactance	Ω / km	0.05
Voltage Drop	V/Km.A	0.231
Rigidity dielectrique		Uo x 2.5 for 10

Rated Short-Time Current of Conductor (1s) 22.6 KA
Rated Short-Time Curent of Screen (1s) 5.1 KA

Phisical Data		
External Diametre	mm	89.2
Aproximative weight	kg/km	7720
Maximum Bending Radius		8 x Da

PACKING		
Length on drum	m	250
Drum wooden size	mm	2 200
Imprimed		By ink jet printing

Mediterranean cables company Bldg. Tefehta - Zahrani , lebanon
Tel : +961 7 420 840 / 850 Fax : +961 7 420 830
E-mail : medcables@hotmail.com
Web : www.med-cables.com