DNV·GL

KEMA TEST REPORT

1206-18

Object	2-core power cable
Type	Cu/MGT/XLPE/LSFOH/LSFOH 0,6/1 (1,2) kV - 2x2,5 mm² - Cu - XLPE
Client	Metal Cable Co., No.41, Hosseini rad Alley, Motahari Corner, Vall Asr. Ave., Tehran, Iran
Manufacturer	Metal Cable Co., NO 28, 16th Street, Kaveh Industrial City, Saveh, Iran
Tested by	DNV GL Netherlands B.V., Arnhem, the Netherlands
Date of tests	15 February to 23 March 2018
Test specification	The tests have been carried out in accordance with IEC 60502-1:2009, subclause 17 and 18.
Summary and conclusion	The object fulfilled the requirements of the performed test.

This report applies only to the object tested. The responsibility for conformity of any object having the same type references as that tested rests with the Manufacturer.
*) as declared by the manufacturer

This report consists of 32 pages in total.

DNV GL Netherlands B.V.

J.P. Fonteijne
Executive Vice President
KEMA Laboratories

KEMA Laboratories

Arnhem, 15 October 2018

INFORMATION SHEET

1 KEMA Type Test Certificate

A KEMA Type Test Certificate contains a record of a series of (type) tests carried out in accordance with a recognized standard. The equipment tested has fulfilled the requirements of this standard and the relevant ratings assigned by the manufacturer are endorsed by DNV GL. In addition, the test object's technical drawings have been verified and the condition of the test object after the tests is assessed and recorded. The Certificate contains the essential drawings and a description of the equipment tested. A KEMA Type Test Certificate signifies that the object meets all the requirements of the named subclauses of the standard. It can be identified by gold-embossed lettering on the cover and a gold seal on its front sheet.
The Certificate is applicable to the equipment tested only. DNV GL is responsible for the validity and the contents of the Certificate. The responsibility for conformity of any object having the same type references as the one tested rests with the manufacturer.
Detailed rules on types of certification are given in DNV GL's Certification procedure applicable to KEMA Laboratories.

2 KEMA Report of Performance

A KEMA Report of Performance is issued when an object has successfully completed and passed a subset (but not all) of test programmes in accordance with a recognized standard. In addition, the test object's technical drawings have been verified and the condition of the test object after the tests is assessed and recorded. The report is applicable to the equipment tested only. A KEMA Report of Performance signifies that the object meets the requirements of the named subclauses of the standard. It can be identified by silver-embossed lettering on the cover and a silver seal on its front sheet.
The sentence on the front page of a KEMA Report of Performance will state that the tests have been carried out in accordance with ..... The object has complied with the relevant requirements.

3 KEMA Test Report

A KEMA Test Report is issued in all other cases. Reasons for issuing a KEMA Test Report could be:

- Tests were performed according to the client's instructions.
- Tests were performed only partially according to the standard.
- No technical drawings were submitted for verification and/or no assessment of the condition of the test object after the tests was performed.
- The object failed one or more of the performed tests.

The KEMA Test Report can be identified by the grey-embossed lettering on the cover and grey seal on its front sheet.
In case the number of tests, the test procedure and the test parameters are based on a recognized standard and related to the ratings assigned by the manufacturer, the following sentence will appear on the front sheet. The tests have been carried out in accordance with the client's instructions. Test procedure and test parameters were based on ..... If the object does not pass the tests such behaviour will be mentioned on the front sheet. Verification of the drawings (if submitted) and assessment of the condition after the tests is only done on client's request.
When the tests, test procedure and/or test parameters are not in accordance with a recognized standard, the front sheet will state the tests have been carried out in accordance with client's instructions.

4 Official and uncontrolled test documents

The official test documents of DNV GL are issued in bound form. Uncontrolled copies may be provided as loose sheets or as a digital file for convenience of reproduction by the client. The copyright has to be respected at all times.

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1 IDENTIFICATION OF THE TEST OBJECT

1.1 Ratings/characteristics of the object tested

Rated voltage, U_c/U (U_m)	0,6/1 (1,2) kV
Rated maximum conductor temperature in normal operation	90 °C
Rated conductor cross-section	2,5 mm²

1.2 Description of the test object

Standard	IEC 60502-1:2009 Clauses 17 to 18
Manufacturer	Metal Cable Co., Saveh, Iran
Type	0,6/1 kV 2x2,5 mm² Cu/MGT/XLPE/LSFOH/LSFOH Cable
Manufacturing year	2017
Quantity submitted	200 m
Rated voltage, U_0/U	0,6/1 (1,2) kV
No. of cores	2
Core identification	core 1 = blue core 2 = black
Overall diameter	14,6 mm
Marking on the oversheath	Metal Cable Co. IEC 60502-1 IEC60331-21 CU/MGT/XLPE/LSFOH/LSFOH 2*2.5 SQMM 0.6/1KV Fire resistance MADE IN IRAN 164-1 2017
Construction	see List of drawings

Conductor

• material	copper, untinned
• cross-section	2,5 mm²
• nominal diameter	2,0 mm
• type	class 2 copper, stranded non-compacted and round
• maximum conductor temperature in normal operation	90 °C

Insulation

• manufacturer	known in KEMA Laboratories' files
• material	XLPE
• nominal thickness	0,7 mm
• insulation colour	blue / black

Fillers and binders

• material	ST_3
• Type (i.e. extruded, yarn)	extruded

Oversheath

• material	LSFOH, type ST8
• nominal thickness	1,8 mm
• nominal overall diameter of cable (D)	14,6 mm
• material designation	8658 NFR
• colour	red
• manufacturer of the material	DYM, Korea

Fire retardant (according to IEC 60332-1) yes

Manufacturing details insulation system

• location of manufacturing	Saveh, Iran
• type of extrusion line	VCV
• type of extrusion	single extrusion
• factory identification of extrusion line	Maillefer
• manufacturer of the extrusion line	Maillefer, Germany
• identification of production batch	164-1
• curing mears	steam
• cooling means	water
• manufacturing length (where cable sample for testing has been taken from)	500 m
• length markings on cable sample sent to KEMA Laboratories	begin: 321 m, end: 521 m

1.3 List of documents

The manufacturer has guaranteed that the object submitted for tests has been manufactured in accordance with the following drawings and/or documents. KEMA Laboratories has verified that these drawings and/or documents adequately represent the object tested. The manufacturer is responsible for the correctness of these drawings and/or documents and the technical data presented.

The following drawings and/or documents have been included in this report:

Drawing no./document no.	Revision
Cable construction	-

2 GENERAL INFORMATION

2.1 The tests were witnessed by

The tests were carried out without a representative of the client present.

2.2 The tests were carried out under responsibility of

Name	Company
B. Vos	DNV GL Netherlands B.V.,
K.S. Nijskens	Arnhem, the Netherlands

2.3 Subcontracting

All tests were subcontracted to DNV GL / Energy Advisory, Arnhem, the Netherlands.

2.4 Purpose of test

Purpose of the test was to verify whether the material complies with the specified requirements.

2.5 Measurement uncertainty

A table with measurement uncertainties is enclosed in this report. Unless otherwise stated, the measurement uncertainties of the results presented in this report are as indicated in that table.

3 CONDUCTOR

Standard and date

Standard IEC 60502-1 clause 5
Test date 1 March 2018

3.1 Measurement of the resistance of the conductor

Item	Unit	Requirement	Measured/determined	
			Blue	Black
Resistance	Ω/km	≤ 7,41	7,07	7,07

Result
The object passed the test.

3.2 Measurement of the number of wires of the conductor

Item	Unit	Requirement	Measured/determined	
Number of wires	-	≥ 7	7	7

Result
The object passed the test.

3.3 Measurement of the diameter of the conductor

Item	Unit	Requirement	Measured/determined	
			Blue	Black
Diameter	mm	-	2,0	2,0

Result
The result is for information only.

4 ELECTRICAL TYPE TESTS

4.1 Measurement of insulation resistance at ambient temperature

Standard and date

Standard IEC 60502-1, clause 17.1
Test date 1 March 2018

Item	Unit	Requirement	Measured/determined	
			Blue	Black
Volume resistivity, ρ at 20 °C	Ω.cm	-	$3,8x10^{-6}$	$3,4x10^{20}$
Insulation resistance constant, K_i at 20 °C	MΩ.km	-	139178	126534

Result

The test results are for information only.

4.2 Measurement of insulation resistance at max. conductor temperature

Standard and date

Standard IEC 60502-1, clause 17.2
Test date 2 March 2018

Item	Unit	Requirement	Measured/determined Blue	Black
Volume resistivity, ρ at 90 °C	Ω.cm	≥ 10^{12}	1,7x10^{16}	1,8x10^{16}
Insulation resistance constant, K_i at 90 °C	MΩ.km	≥ 3,67	61176	66740

Result

The object passed the test.

4.3 Voltage test for 4 h

Standard and date

Standard	IEC 60502-1, clause 17.3
Test date	6 March 2018

Environmental conditions

Ambient temperature	23 °C

Characteristic test data

Temperature of test object	21 °C
Water temperature	21 °C

Testing arrangement		Voltage applied, 50 Hz		Duration
Voltage applied to	Earth connected to	... x U_0	kV	h
Conductors	Water tank	4	2,4	4

Requirement

No breakdown of the insulation shall occur.

Result

The object passed the test.

5 NON-ELECTRICAL TYPE TESTS

5.1 Measurement of thickness of insulation

Standard and date

Standard IEC 60502-1, clause 18.1
Test date 6 March 2018

Thickness	Unit	Requirement	Specified	Measured/determinec	
				Blue	Black
Nominal	mm	-	0,7	-	-
Average	mm	≥ 0,7	-	0,8	0,8
Minimum (t_m)	mm	> 0,53	-	0,66	0,77

Result

The object passed the test.

5.2 Measurement of thickness of non-metallic sheaths

Standard and date

Standard	IEC 60502-1, clause 18.2
Test date	6 March 2018

Oversheath

Thickness	Unit	Requirement	Specified	Measured/determined
Nominal	mm	≥ 1,8	1,8	-
Average	mm	-	-	1,9
Minimum (t_m)	mm	> 1,24	-	1,79

Result

The object passed the test.

5.3 Tests for determining the mechanical properties of insulation before and after ageing

Standard and date

Standard	IEC 60502-1, clause 18.3
Test date	8 to 15 March 2018

Characteristic test data

Temperature during ageing	135 ± 3 °C
Duration	7 x 24 h (22 February to 1 March 2018)

Item	Unit	Requirement	Measured/determined	
			Blue	Black
Without ageing				
Tensile strength	N/mm²	≥ 12,5	20,5	16,8
Elongation at break	%	≥ 200	427	416
After ageing in air oven				
Tensile strength				
• value after ageing	N/mm²	-	20,3	20,6
• variation	%	± 25 max.	-1	22
Elongation at break				
• value after ageing	%	-	367	377
• variation	%	± 25 max.	-14	-9

Result

The object passed the test.

5.4 Tests for determining the mechanical properties of non-metallic sheaths before and after ageing

Standard and date

Standard	IEC 60502-1, clause 18.4
Test date	12 March 2018

Characteristic test data (oversheath)

Temperature during ageing	100 ± 2 °C
Duration	7 x 24 h (22 February to 1 March 2018)

Oversheath

	Unit	Requirement	Measured/determined
Without ageing			
Tensile strength	N/mm²	≥ 9,0	13,0
Elongation at break	%	> 125	193
After ageing in air oven			
Tensile strength			
• value after ageing	N/mm²	> 9,0	14,4
• variation	%	± 40 max.	11
Elongation at break			
• value after ageing	%	> 100	180
• variation	%	± 40 max.	-7

Result

The object passed the test.

5.5 Additional ageing test on pieces of completed cables

Standard and date

Standard IEC 60502-1, clause 18.5
Test date 8 to 15 March 2018

Characteristic test data

Temperature during ageing 100 ± 2 °C
Duration 7 x 24 h (22 February to 1 March 2018)

Insulation

Item	Unit	Requirement	Measured/determined	
			Blue	Black
Without ageing				
Tensile strength	N/mm²	≥ 12,5	20,5	16,8
Elongation at break	%	≥ 200	427	410
After ageing in air oven				
Tensile strength				
• value after ageing	N/mm²	-	18,7	18,0
• variation	%	± 25 max.	-9	10
Elongation at break				
• value after ageing	%	-	365	468
• variation	%	± 25 max.	-15	14

Oversheath

Item	Unit	Requirement	Measured/determined
Without ageing			
Tensile strength	N/mm²	> 9,0	13,0
Elongation at break	%	≥ 125	193
After ageing in air oven			
Tensile strength			
• value after ageing	N/mm²	> 9,0	13,9
• variation	%	+ 40 max.	7
Elongation at break			
• value after ageing	%	> 100	163
• variation	%	± 40 max.	-15

Result

The object passed the test.

5.6 Pressure test at high temperature on non-metallic sheaths

Standard and date

Standard	IEC 60502 1, clause 18.7
Test date	2 March 2018

Characteristic test data (oversheath)

Temperature during ageing	80 ± 2 °C
Heating time	4 h
Load	5 N

Oversheath

Item	Unit	Requirement	Measured/Determined
Depth of indentation	%	≤ 50	9

Result

The object passed the test.

5.7 Test on PVC insulation and sheaths and halogen free sheaths at low temperatures

Standard and date

Standard	IEC 60502-1, clause 18.8
Test date	6 March 2018

Characteristic test data (oversheath)

Temperature	-15 ± 2 °C
Period of application	16 h
Mass of hammer	500 g

Oversheath

Item	Unit	Requirement	Measured/Determined
Cold elongation test	%	≥ 20	100
Cold impact test	-	No cracks	No cracks

Result

The object passed the test.

5.8 Hot set test for XLPE insulation

Standard and date

Standard IEC 60502-1, clause 18.11
Test date 5 March 2018

Characteristic test data

Temperature 200 ± 3 °C
Time under load 15 min
Mechanical stress 20 N/cm²

Item	Unit	Requirement	Measured/determined	
			Blue	Black
Elongation under load	%	< 175	30	26
Permanent elongation after cooling	%	≤ 15	-3	-2

Result

The object passed the test.

5.9 Water absorption test on insulation

Standard and date

Standard IEC 60502-1, clause 18.13
Test date 18 February to 9 March 2018

Characteristic test data

Temperature 85 ± 2 °C
Duration 14 x 24 h (21 February to 7 March 2018)

Item	Unit	Requirement	Measured/determined	
			Blue	Black
Variation of mass	mg/cm²	< 1	0,13	0,10

Result

The object passed the test.

5.10 Fire tests

5.10.1 Flame spread test on single cables

Standard and date

Standard IEC 60502-1, clause 18.14.1
Test date 6 March 2018

Characteristic test data

Overall diameter of test piece 14,6 mm
Time for flame application 60 s
Flame type 1 kW pre-mixed flame

Complete cable	Unit	Requirement	Measured/determined
The distance between the lower edge of the top support and the onset of charring	mm	> 50	410
The distance between the lower edge of the top support and charring extends downwards to a point	mm	< 540	500

Result

The object passed the test.

5.10.2 Flame spread test on bunched cables

Standard and date

Standard IEC 60502-1, subclause 18.14.2
Test date 28 February 2018

Characteristic test data

Flame application time 20 min
Number of burners 1

Item	Unit	Requirement	Calculated/measured
Total volume of non-metallic materials	l/m	-	25,7
Number of test pieces		≥ 2	6
Number of layers	-	≥ 1	2
Time to extinction of all burning or glowing	min	≤ 60	22
Extent of damage	m	≤ 2,5	0,8

Result

The object passed the test.

5.10.3 Smoke emission test

Standard and date

Standard IEC 60502-1, clause 18.14.3
Test date 19 March 2018

Characteristic test data

Number of cables 3

Item	Unit	Requirement	Calculated/measured
Light transmittance	%	≥ 60	84

Result

The object passed the test.

5.10.4 Acid gas emission test

Standard and date

Standard	IEC 60502-1, clause 18.14.4
Test date	12 to 23 March 2018

Amount of halogen acid gas

HCl content of ..	Unit	Requirement	Calculated/measured
Thermoplastic insulation (mixed)	%	≤ 0,5	<0,02
Mica tape	%	≤ 0,5	<0,02
Filler	%	≤ 0,5	<0,02
Oversheath	%	≤ 0,5	<0,02

Remarks

- No requirements for conformity are included in IEC 60754-1.
- The method specified in IEC 60754-1 is intended for type testing of individual components used in the cable construction. The use of this method will enable the requirements for individual components of a cable construction to be stated in the appropriate cable specification.

Result

The object passed the test.

5.10.5 pH and conductivity test

Standard and date

Standard	IEC 60502-1, clause 18.14.5
Test date	12 to 23 March 2018

pH test

pH value of ..	Unit	Requirement	Calculated/measured
Thermoplastic insulation (mixed)	%	> 4,3	4,7
Mica tape	%	≥ 4,3	4,4
Filler	%	> 4,3	5,4
Oversheath	%	≥ 4,3	4,8

Conductivity test

Conductivity of ..	Unit	Requirement	Calculated/measured
Thermoplastic insulation (mixed)	µS/mm	≤ 10	<0,5
Mica tape	µS/mm	< 10	1
Filler	µS/mm	≤ 10	<0,5
Oversheath	µS/mm	< 10	<0,5

Result

The object passed the test.

5.10.6 Fluorine content test

Standard and date

Standard IEC 60502-1, clause 18.14.6
Test date 12 to 23 March 2018

Amount of fluorine

Fluorine content of ..	Unit	Requirement	Calculated/measured
Thermoplastic insulation (mixed)	%	≤ 0,1	<0,1
Mica tape	%	< 0,1	<0,1
Filler	%	≤ 0,1	<0,1
Oversheath	%	< 0,1	<0,1

Result

The object passed the test.

5.11 Shrinkage test for XLPE insulation

Standard and date

Standard IEC 60502-1, clause 18.16
Test date 7 March 2018

Characteristic test data

Length of cable sample 300 mm
Temperature 130 ± 1 °C
Duration 1 h

Item	Unit	Requirement	Measured/determined	
			Blue	Black
Shrinkage	%	≤ 4	3	3

Result

The object passed the test.

5.12 Water absorption test for halogen free oversheaths

Standard and date

Standard	IEC 60502-1, clause 18.22
Test date	9 to 16 March 2018

Characteristic test data

Temperature	70 ± 2 °C
Duration	1 x 24 h
Test method	gravimetric

Item	Unit	Requirement	Measured/determined
Increase of mass	mg/cm²	≤ 10	0,5

Result

The object passed the test.

6 VERIFICATION OF CABLE CONSTRUCTION

Verification of cable construction was carried out in accordance with clauses 5-13 of IEC 60502-1. The results are presented below.

	Observed/determined
Marking on the cable	METAL CABLE CO. IEC 60502-1, IEC 60331 CU/MGT/XLPE/LSFOH/LSFOH 2x2,5 SQMM 0,6/1 kV MADE IN IRAN 2017
Construction	Copper, class 2 stranded circular conductor
	Mica glass tape
	Insulation XLPE (blue, black)
	Filler ST8 (LSFOH)
	Outer sheath ST8 (LSFOH
Outer diameter of the cable, average	14,5 mm
Outer diameter of the cores, average	Blue: 4.6 mm Black: 4,8 mm

Result

No significant deviations from the specified requirements are found.

8 DRAWING

2X2.5 CU/MGT/XLPE/LSFOH

Ø Conductor	2.00mm
Ø Mica Tape	2.78mm
Ø Insulation	4.40mm
Ø Twist Cores	8.80mm
Ø Filler	10.80mm
Ø Outer Sheath	14.60mm

9 MEASUREMENT UNCERTAINTIES

The measurement uncertainties in the results presented are as specified below unless otherwise indicated.

Measurement	Measurement uncertainty
Tensile strength test	1%
Measurement of dimensions	5 µm
Measurement loss of mass	0,11 mg: 8.0 gr
Measurement of conductor resistance	0,03% of measured value
Measurement at low temperature	0,1 °c
Measurement in heating cabinets	0,1 °c
Voltage test	2.10^{-3}.u + 20v 2.10^{-3}.i + 0,2%