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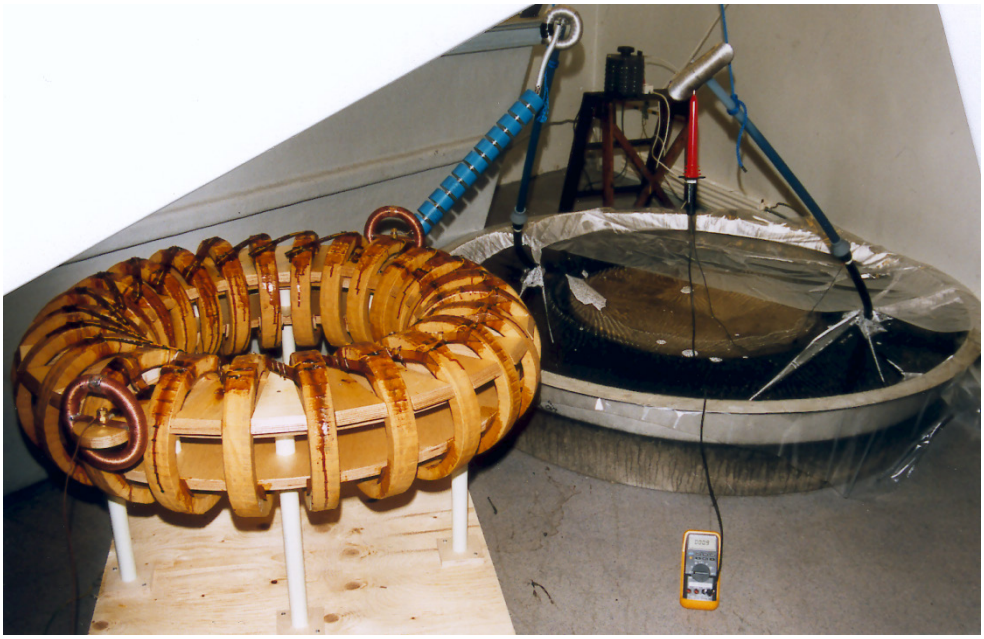
LR F2545 - Restricted

Test report

Long Term 500 Hz Test of an XLPE Cable, 24 kV 1 x 300 mm2 Cu

Author
Hallvard Faremo



SINTEF Energy Research
Electric Power Technology
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SINTEF Energi AS
SINTEF Energy Research
Address:
Postboks 4761 Sluppen
NO-7465 Trondheim
NORWAY

Telephone:+47 73597200
Telefax:+47 73597250

energy.research@sintef.no
www.sintef.no/energi
Enterprise /VAT No:
NO 939 350 675 MVA

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Long Term 500 Hz Test of an XLPE Cable, 24 kV 1 x 300 mm2 Cu

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Hallvard Faremo

CLIENT
LG Chem. Ltd. LG Twin Towers, 20, Yeouido-dong, KOREA

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Martin, (TY) Yang.

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TEST OBJECT
12/20 (24) kV XLPE cable with 300 mm^2 Cu conductor manufactured by National Cable Industries (NCI), Sharjah, UAE

TEST OBJECT RECEIVED
2011-05-05

TEST PROGRAM
Cenelec HD 605 Method 5.4.6

TEST LOCATION
SINTEF High Voltage Laboratory

DATE OF TEST
Autumn 2011

ABSTRACT

90 m of 12/20 (24) kV XLPE cable with a 300 mm^2 copper conductor manufactured by National Cables Industries, Sharjah, in UAE, has been tested according to Cenelec HD 605 S2: 2008, Test No 5.4.6 Long duration test at 500 Hz.

The cable fulfilled the test requirements of HD 620 S2:2010 to the 500 Hz long duration test.

According to HD 605 / HD 620, this qualification test covers MV cables with the actual insulation and screen materials up to and including 42 kV.

The test results relate only to the items tested

PREPARED BY
Hallvard Faremo

SIGNATURE

APPROVED BY
Rolf Hegerberg

SIGNATURE

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VERSION	DATE	DESCRIPTION OF VERSION
Draft	2012-01-02	Issued for Client's comments
Rev 01	2012-01-04	Clients comments included

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TEST OBJECT

The 90 m cable cores {12/20 (24) kV XLPE cables, 300 mm^2 Cu stranded conductor and strippable insulation screen} tested is schematically shown in Figure 1.

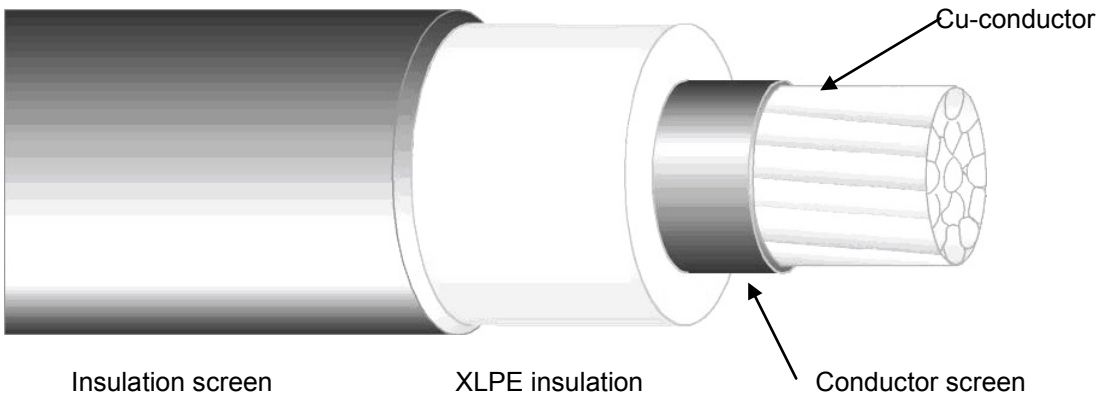

Figure 1: Cross section of the test cable 1 x 300 mm^2 12/20 (24) kV manufactured by National Cable Industries (NCI), Sharjah, UAE

XLPE insulation:	Peroxide cured XLPE
Conductor screen:	Bonded
Insulation screen:	Strippable

SUMMARY OF TEST RESULTS

LONG TERM AGEING TEST AT 500 Hz			
Tests performed in accordance with CENELEC HD 605 S2:2008 Test No 5.4.6			
Test object: 90 m 12/20 (24) kV XLPE cable, 1x300 mm^2 Cu conductor and strippable insulation screen			*Date(s) of test:* 2011-05-09 - 2011-10-24
Test requirements			**Corresponding tests**
Preconditioning:			
Temperature	(°C)	55±5	53 - 57
Duration	(h)	500	500
Water quality		Tap water [1]	
High voltage AC withstand test:			
Voltage	(kV)	$10U_o$	120 ± 1
Frequency	(Hz)	50	50
Duration	(min)	1	1
Temperature	(°C)	Ambient	22
Ageing parameters:			
Voltage	(kV_{rms})	$3U_0$	36 ± 0.5
Frequency	(Hz)	500	500
Temperature [2]	(°C)	40 ± 5	40 ± 1
Water Quality		Tap water [1]	
- Acidity	(pH)	6.0 – 7.5	6.5 – 7.5
Test duration	(h)	3 000	3 010
Test requirement	No BD [3] during ageing		No BD
Evaluation after ageing:			
Number of samples		6	6
Test procedure (50 Hz, Ambient):	AC step test; start $3U_0$		36 kV
	Increment U_0 every 5 min		12 kV
Test requirements:			
BD field all samples [4]	(kV/mm)	> 14	> 25.5
BD field ≥ 4 samples	(kV/mm)	> 18	> 28.0
BD field ≥ 2 samples	(kV/mm)	> 22	> 30.6

Notes to the table:
1) Added 0.3 g NaCl per liter
2) Isothermal ageing
3) BD = Breakdown
4) Maximum electric field at conductor screen

DETAILED TEST RESULTS

PRECONDITIONING

The preconditioning at 55 ^{0}C was carried out in a 2 m^3 stainless steel water tank with 800 ℓ tap water added NaCl; 0.3 g/ℓ.

HIGH VOLTAGE AC WITHSTAND TEST

A high voltage AC withstand test at $10U_0$ (120 kV) for 1 minute was performed in a grounded tap-water bath.

The test was performed at room temperature.

No breakdown occurred.

AGEING

The ageing was performed in a polyester tank as shown in Figure 2. The 500 Hz resonance circuit is schematically shown in Figure 5. The bath temperature was kept at 40 ^{0}C by self regulating heating cables placed in the bottom of the tank.

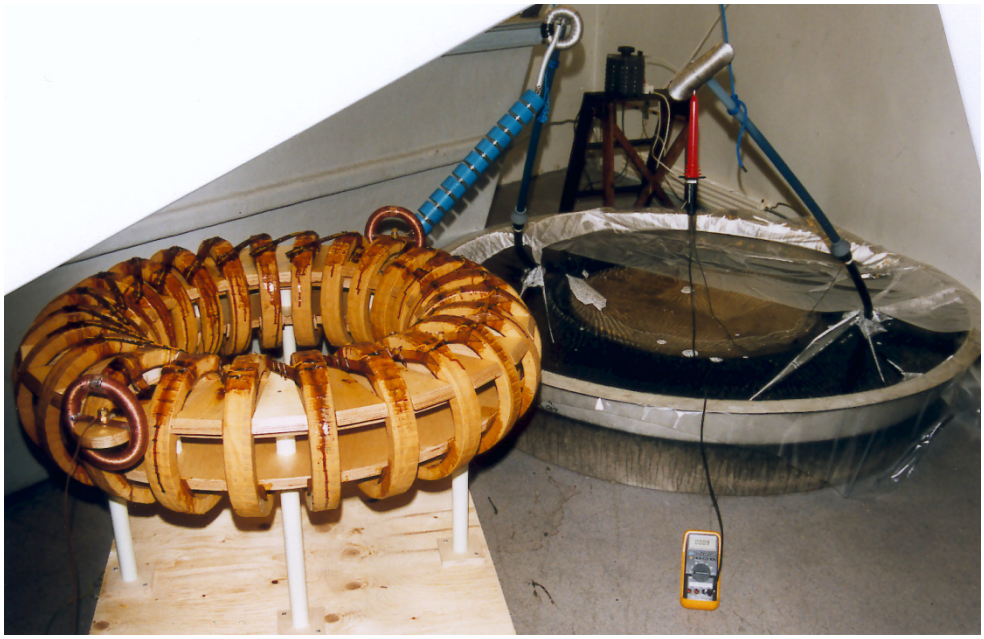

Figure 2: Ageing set-up.

BREAKDOWN TEST AFTER AGEING

Six test objects were prepared from the aged cable. The two ends of the aged cable (2 – 3 m) which had not been totally submerged during the ageing were cut off and discarded. De-ionized water terminations were fitted to the samples before breakdown testing (see Figure 3). The tests are performed at room temperature. The results of the AC step test are shown in Table 1. The computed maximum electrical breakdown field stress at the conductor is also included for each sample.

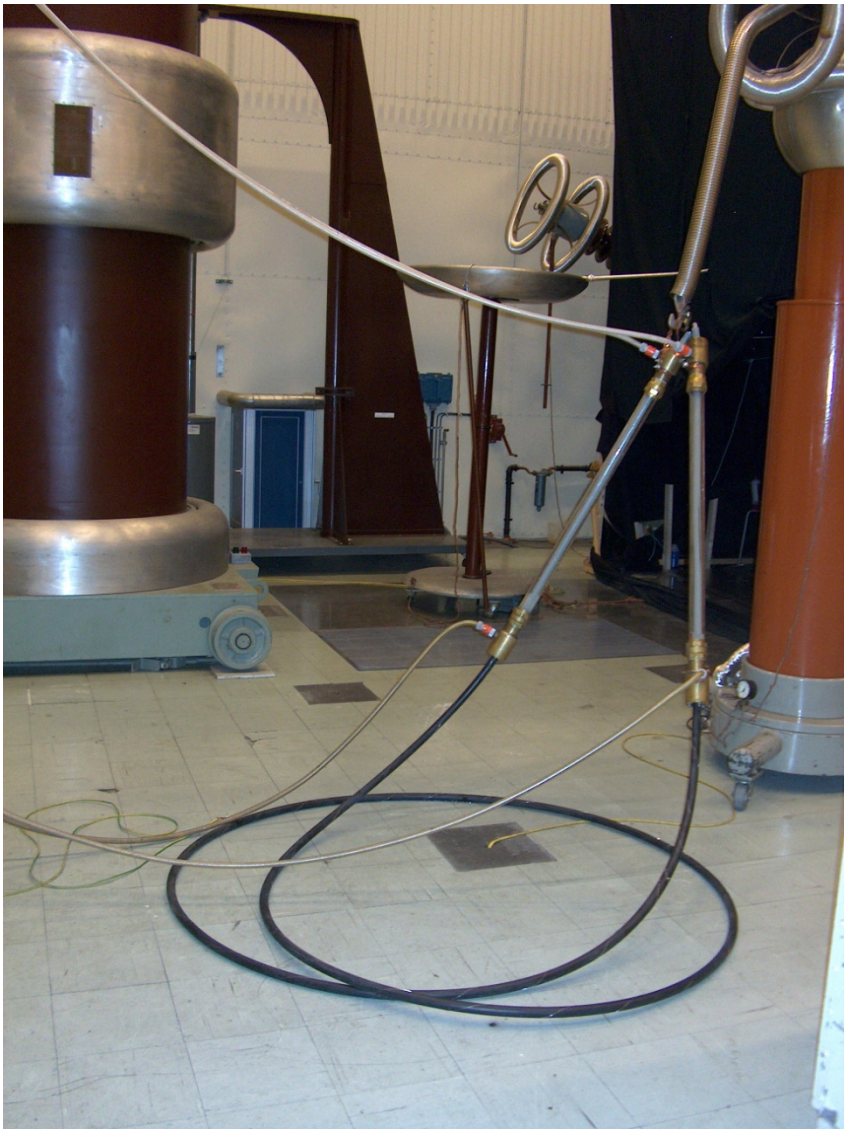

Figure 3: A cable mounted for AC breakdown strength tests. 1 m long de-ionized water terminations were used.

Table 1: AC step test breakdown values for the NCI cable after ageing. The test objects are numbered in the order they were cut from the cable.

Test Object	Breakdown Voltages		Breakdown Stress (Max field at the conductor screen)
	kV	U / U_o	kV/mm
NCI-1	132	11	28.0
NCI-2	144	12	30.6
NCI-3	120	10	25.5
NCI-4	132	11	28.0
NCI-5	132	11	28.0
NCI-6	144	12	30.6

$$E_{max} = \frac{U}{\frac{d}{2} \cdot \ell n \frac{D}{d}}$$

E_{max}	=	Breakdown stress at the conductor screen [kV/mm]
U	=	Breakdown voltage [kV]
d	=	Diameter over the conductor screen = 22.9 mm
D	=	Diameter over the XLPE insulation = 34.55 mm

Ageing performance is usually presented applying extreme value statistics of the Weibull type to analyze the breakdown data. In Figure 4, the Weibull curve for the breakdown values are presented and compared with the required breakdown field stress values (CENELEC HD620 S2:2010 Part 10 Section I).

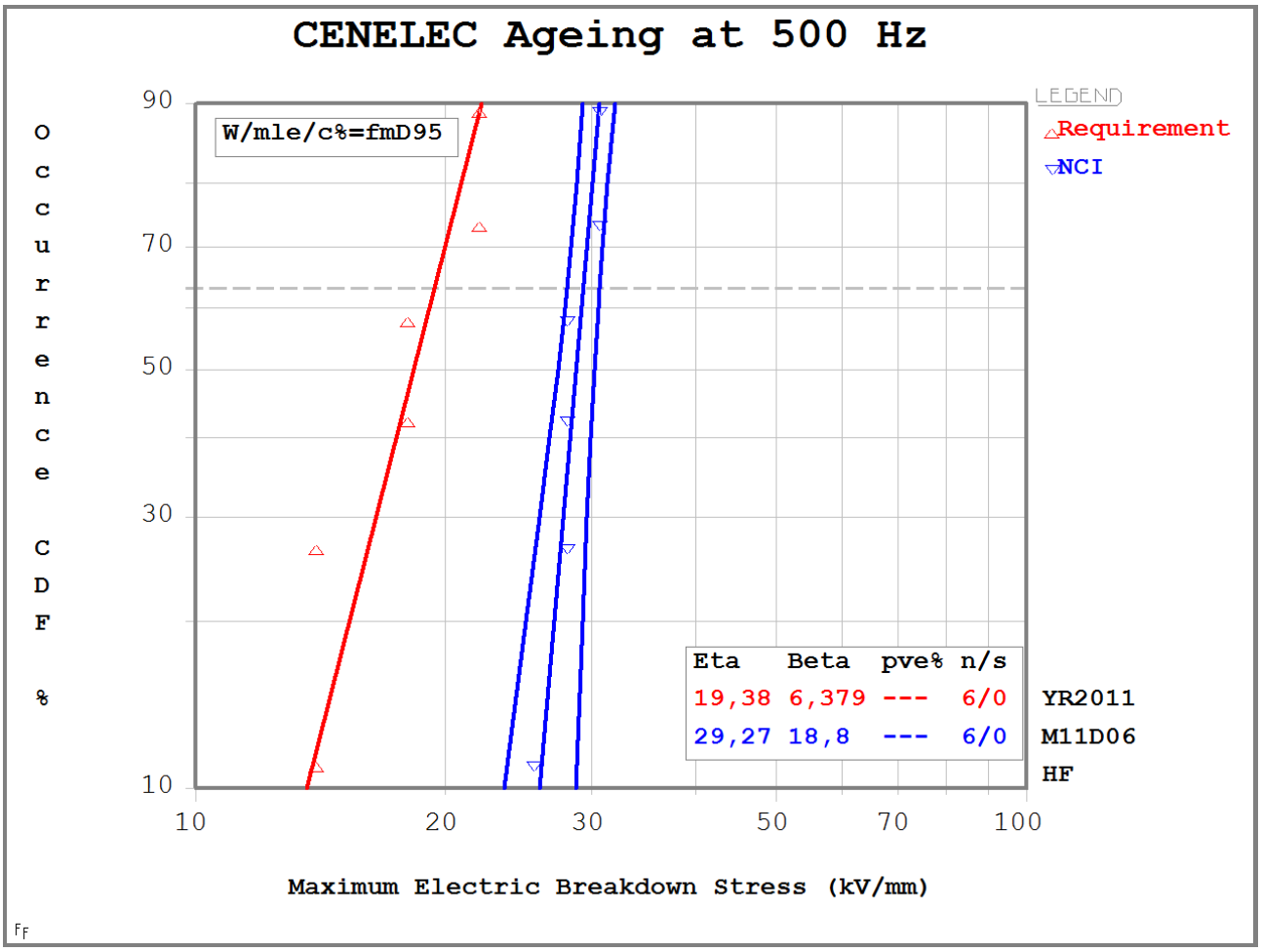

Figure 4: AC breakdown values (maximum electric field at the conductor screen) for the NCI cable according to Weibull Statistics, 95% confidence level.

Eta: 63.2% breakdown stress
Beta: Shape factor
n / s: Number of test objects / Number of suspensions

500 Hz TEST CIRCUIT

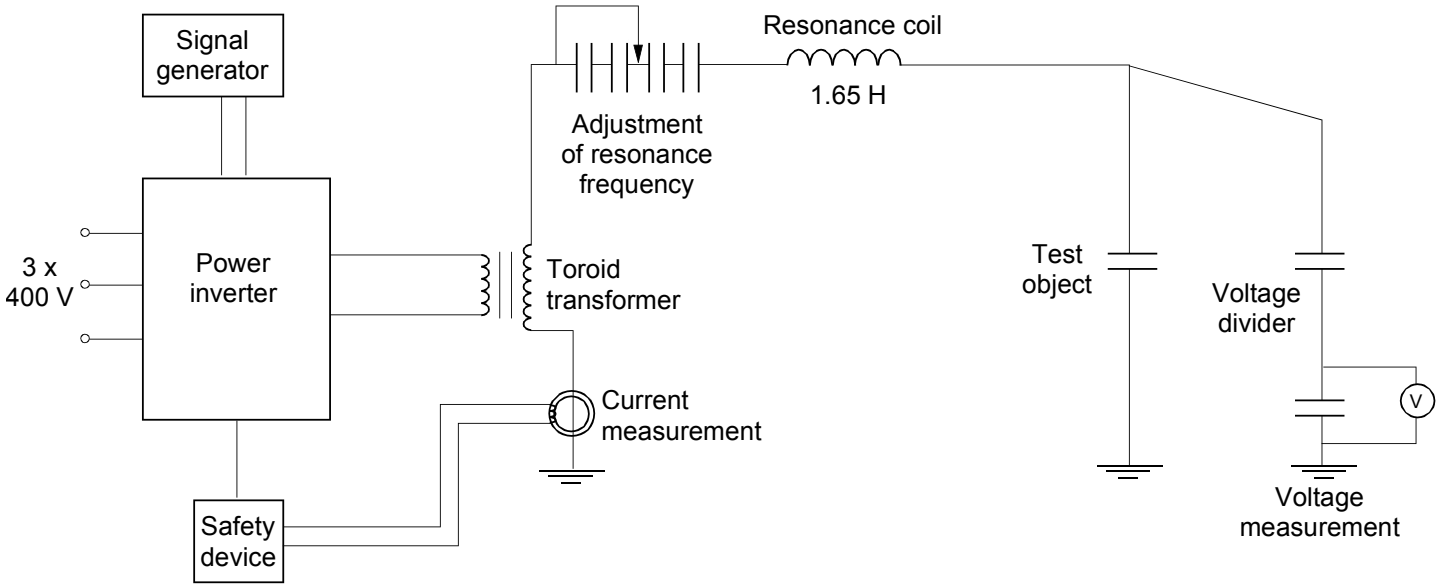

Figure 5: Schematic 500 Hz ageing test set-up.

EQUIPMENT

500 Hz Long Term Ageing Test	
Voltage regulator (3 x 400 V)	B01-0363
Universal power inverter	B03-0364
Resonance coil	L02-0044
Toroid transformer	B01-0716
Voltage divider	K03-0136
Voltmeter (500 Hz)	S03-0341
Temperature control unit	N02-0085

Calibrated 2011-02; next calibration spring 2012.

AC Breakdown Tests	
Transformer	B1-437
Control desk	B1-437-3
Voltmeter	C6-033
Measuring capacitor	M2-29
Deionised Water Terminations	SINTEF

Calibrated: 2010-08-27; next calibration autumn 2012.

CONCLUSIONS

90 m of 12/20 (24) kV XLPE cable with a 300 mm^2 copper conductor manufactured by National Cables Industries, Sharjah, in UAE, has been tested according to Cenelec HD 605 S2: 2008, test no 5.4.6 Long duration test at 500 Hz.

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