

CAPACITOR VOLTAGE TRANSFORMER

CCV 245

TEST CERTIFICATE

N°: 25 877

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CAPACITOR VOLTAGE TRANSFORMER

Type :	CCV 245
Serial number :	XE 91 200-01
Highest primary voltage :	245 kV
Power frequency withstand voltage	460 kV
Impulse withstand voltage :	1050 kV
Rated frequency :	50 Hz
Ratio :	220 000 / $\sqrt{3}$ V // 100 / $\sqrt{3}$ / 100 / $\sqrt{3}$ V
Burden and accuracy : 1a - 1n winding	75 VA cl 0.5
2a - 2n winding	75 VA cl 3P
	Simultaneous loaded
Standards :	IEC 186 & 358
Rated voltage factor :	1.5 Un - 30 s
Thermal burden :	500 VA
Rated capacitance at 50 Hz :	4 400 pF - 5 % ; +10 %
Outline drawing :	8 162 976

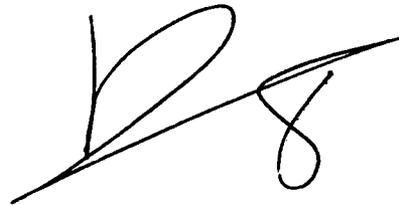
Montrouge, 16 June 2 000

Executive responsible for the tests

Quality Manager

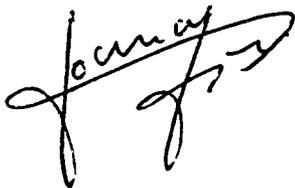
R. TORRES

V. DENIZEAUX



Technical manager

A. JOUNAY



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ESSAIS REALISES – TETS LIST

N° :	Consistance des essais Table of contents Contenido de las pruebas	Références References Referencias	Page Page Pagina	Conclusion des essais (1) Conclusion
1	Vérification du marquage des bornes . Verification of terminal markings. Rating plate marking.	IEC 186		C
2	Contrôle de précision. Accuracy check.	IEC 186	15	C
3	Mesure de la tangente et de la capacité à fréquence industrielle. Capacitance and tangent of the loss angle.	IEC 358	3	C
4	Mesure des décharges partielles. Partial discharge test.	IEC 358	3	C
5	Essai de tenue à fréquence industrielle du diviseur capacitif. Power frequency test on the capacitor divider.	IEC 358	4	S
6	Essai de tenue à fréquence industrielle de l'élément électro-magnétique . Power frequency test on the electromagnetic unit .	IEC 358	4	S
7	Essai de tenue à fréquence industrielle sur la borne à basse tension. Power frequency test on low voltage terminal.	IEC 358	4	S
8	Essai de tenue à fréquence industrielles sur les enroulements secondaires. Power frequency test on secondary windings.	IEC 358	4	S
9	Essai de tenue aux chocs de foudre. Lightning impulse test.	IEC358 & 60-1	5	S
10	Essai de tenue aux chocs de foudre de l'élément électro-magnétique. Lightning impulse test on the electromagnetic unit.	IEC 358 & 60-1	6	S
11	Essai de tenue en court-circuit secondaire. Short-circuit withstand capability test .	IEC 358	7 - 8	S
12	Vérification de la précision en régime transitoire. Transient response test .	IEC 60044-5 CDV- project	9 - 10	C
13	Essai de ferro-résonance. Ferro-resonance test.	IEC 186 & IEC 358	11	S
14	Essai d'échauffement. Temperature rise test.	IEC 186	12 - 13	S
15	Mesure du taux de transmission haute fréquence. Measurement of the transmission factor of high frequency overvoltage.	IEC 186 CDV- project	14	S
16	Vérification de la précision au titre des essais individuels de série. Accuracy test.	IEC 186	15 - 16	S
17	Mesure de la capacité et de la conductance parasites de la borne basse tension. Stray capacitance and stray conductance of the low voltage terminal.	IEC 358 Annex B	17	C
18	Mesure de la capacité apparente et de la résistance équivalente série à haute fréquence. High frequency capacitance and equivalent serie resistance.	IEC 358 Annexe B	18	C
19	Détermination du coefficient de température. Temperature coefficient determination.	IEC 358	19 to 22	C
20	Essai d'étanchéité du diviseur de tension capacitif. Tightness of capacitor voltage divider.	IEC 358	23	S
21	Vérification de la précision en variation de fréquence. Accuracy test with frequency variation.		94 & 95	C
22	Annexe Annex. Electrical diagram - Outline drawing		24 to 93 96 - 97	

(1) S : satisfaisant-satisfactory-satisfactorio. C : conforme-conform-conforme.

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CAPACITANCE AND LOSSES FACTOR MEASUREMENT

	Tension d'essai Test voltage Tensi'on de prueba	Tangente δ Tangent δ Tangente δ	Capacité Capacitance Capacitancia
Mesures réalisées avant essai diélectrique CT Measurements before power frequency test on CT Medicìones realizadas antes de la prueba dieléctrica sobre CT	10 kV	0.71×10^{-3}	4 590 pF
Mesures réalisées avant essai diélectrique CT Measurements before power frequency test on CT Medicìones realizadas antes de la prueba dieléctrica sobre CT.	127 kV	0.55×10^{-3}	4 589 pF
Mesures réalisées après essai diélectrique CT Measurements after frequency test on CT. Medicìones realizadas despues de la prueba dieléctrica sobre CT.	127 kV	0.48×10^{-3}	4 587 pF

Tests have been done at the ambient temperature of $20^\circ\text{C} \pm 2^\circ\text{C}$.

Capacitance variations are lower than the one corresponding to a puncture of one element. **The tests are satisfactory.**

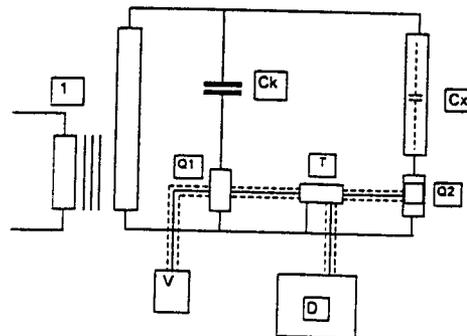
PARTIAL DISCHARGES MEASUREMENTS

Partial discharges measurements are made according to IEC 186 (2-1987) clause 16.4.2 point A, continuously to the power test frequency and according also to IEC 44-4.

Tension de mesure Voltage measurement Tension de medicìon	Niveau mesuré en pC Measured level in pC Medicìon en pC	Limites en pC Limits in pC Limites en pC
1.2 Um 294 kV	< 5	10
0.7 Um 171 kV	< 2	2

Test is satisfactory.

DIAGRAM



1: Transformateur élévateur de tension
 Ck: Condensateur de couplage
 Cx: Objet en essai
 T: Transformateur différentiel
 Q1: Quadripôle pour DP et mesure de la tension
 Q2: Quadripôle pour DP
 V: Voltmètre
 D: Détecteur de DP (Robinson modèle 5)

Set-up transformer
 Coupling transformer
 Apparatus in test
 Differential transformer
 Voltage measurement device
 DP measurement device
 Voltmeter
 DP detector (5 Robinson model)

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POWER FREQUENCY TESTS

Referencas	Consistance des essais	Tension en kV	Fréquence d'essai en Hz	Durée de l'essai en secondes	Conclusion des essais (1)
Referencas	Table of contents	Voltage in kV	Test frequency	Duration of test in seconds	Conclusion
Referencias	Contenido de las pruebas	Tensiòn en kV	Frecuencia en Hz	Duraciòn de la Prueba en segundos	Conclusiòn
IEC 60044-2	Essais diélectriques à fréquence industrielle des enroulements secondaires entre eux et la masse. Power frequency test on secondary windings between secondaries and to earth. Ensayo dielectricos de los arrollamientos secundarios entre ellos y la massa.	3	50	60	S
IEC 60044-2	Essais diélectriques sur C total. Power frequency test on C total. Ensayos dielectricos sobre C total.	460	50	60	S
IEC 60044-2	Essais diélectriques entre la borne P2 et la masse. Power frequency test between P2 and to earth. Ensayos dielectricos entre P2 y la massa.	10	50	60	S
IEC 60044-2	Essais diélectriques entre la borne HF et la masse. Power frequency test between HF and to earth. Ensayos dielectricos entre el borne HF y la massa.	10	50	60	S
IEC 60044-2	Essais diélectriques entre les extrémités de la self d'accord. Dielectric test on damping impedance medium voltage. Ensayos dielectricos sobre las extremidades del inductor de acorde.	10	300	20	S
IEC 60044-2	Essai diélectrique entre les extrémités de l'élément électro-magnétique. Power frequency test between the terminals of the electro-magnetic element. Ensayos dielectricos sobre las extremidades del elemento electro-magnetico.	32	300	20	S

(1) S : satisfaisant-satisfactory-satisfactorio. C : conforme-conform-conforme.

Tests done after short-circuit test :

IEC 60044-2	Essais diélectriques à fréquence industrielle des enroulements secondaires entre eux et la masse. Power frequency test on secondary windings between secondaries and to earth. Ensayos dielectricos de los arrollamientos secundarios entre ellos y la massa.	3	50	60	S
IEC 60044-2	Essais diélectriques entre la borne N et la masse. Power frequency test between N and to earth. Ensayos dielectricos entre N y la massa.	4	50	60	S
IEC 60044-2	Essais diélectriques entre les extrémités de la self d'accord. Dielectric test on damping impedance medium voltage. Ensayos dielectricos sobre las extremidades del inductor de acorde.	9	300	20	S
IEC 60044-2	Essai diélectrique entre les extrémités de l'élément électro-magnétique. Power frequency test between the terminals of the electro-magnetic element. Ensayos dielectricos sobre las extremidades del elemento electro-magnetico.	29	300	20	S

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The electromagnetic unit has successfully withstood the required dielectric tests after the short-circuit test.

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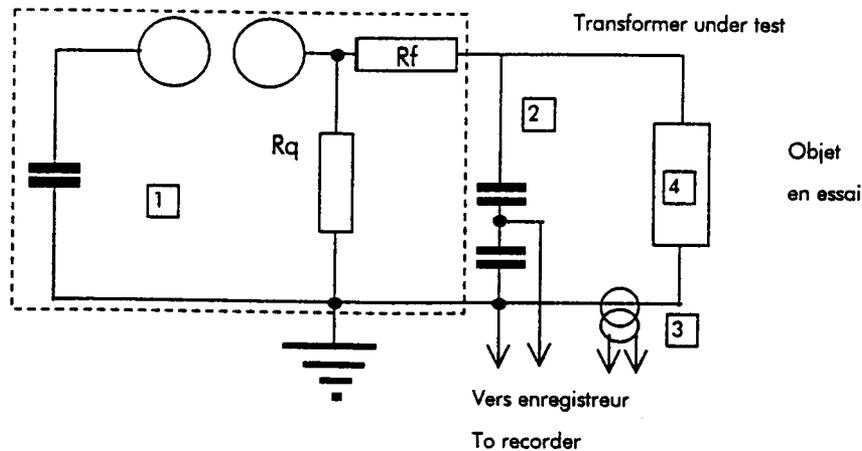
LIGHTNING IMPULSE TEST

The lightning impulse test was performed according to IEC on the complete apparatus n°: XE 91 200-01.
 The impulse wave is of the conventional form (approximately 1.2 / 50 μ s) according to IEC 60, but a front time of up to 5 μ s is acceptable to take into account the high value of the capacitance and the limitations of the testing equipment.
 The high voltage is applied between the HV terminal (A), and the HF and N terminals connected to the mass. The LV windings are connected to the mass. The apparatus mass is grounded.
 The impulse voltage is measured through a capacitive divider by an impulse voltmeter and recorded.
 The current is measured across a wide band current transformer, and recorded.
 After calibration impulses at approximately half voltage and 525 kV,

- 15 negative full impulses at 1050 kV, and
- 15 positive full impulses at 1050 kV

have been applied to the apparatus.

TEST DIAGRAM



TEST RESULTS

Examination of the impulse voltage recordings shows that no internal or external flashover has occurred.
 The capacitance measurements below taken before and after the test, show that no internal puncture has occurred.

	Tg δ	Capacitance
Measurement before impulse test	0.48 x 10 ⁻³	4587 pF
Measurement after impulse test	0.50 x 10 ⁻³	4586 pF

Measurements were performed at room temperature of 21 °C \pm 2 °C.

The non-significant capacitance change ensures that no puncture has occurred.

The accuracy measurement test taken before and after the test, show that no internal puncture has occurred in the electromagnetic unit (see accuracy results page: 15-16).

The non-significant accuracy measurements change ensures that no puncture has occurred.

See oscillograms in annex: 1, pages: 25 to 41.

The lightning impulse test is satisfactory.

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LIGHTNING IMPULSE TEST ON ELECTROMAGNETIC UNIT

The lightning impulse test was performed on the electromagnetic unit n°: XE 91 200-01.

The impulse wave is of the conventional form (approximately 1.2 / 50 μ s) according to IEC 60.

The impulse voltage applied is the result of the measured capacitances values C1 and C2 and is calculated as follows:

$$U = 1050 \text{ kV} \times C1 / (C1 + C2)$$

$$U = 1050 \text{ kV} \times 4930 / (4930 + 66510) = 72.4 \text{ kV}$$

The high voltage is applied between the medium voltage transformer terminal, and the HF and N terminals connected to the mass. The LV windings are connected to the mass. The apparatus mass is grounded.

The impulse voltage is measured through a capacitive divider by an impulse voltmeter and recorded.

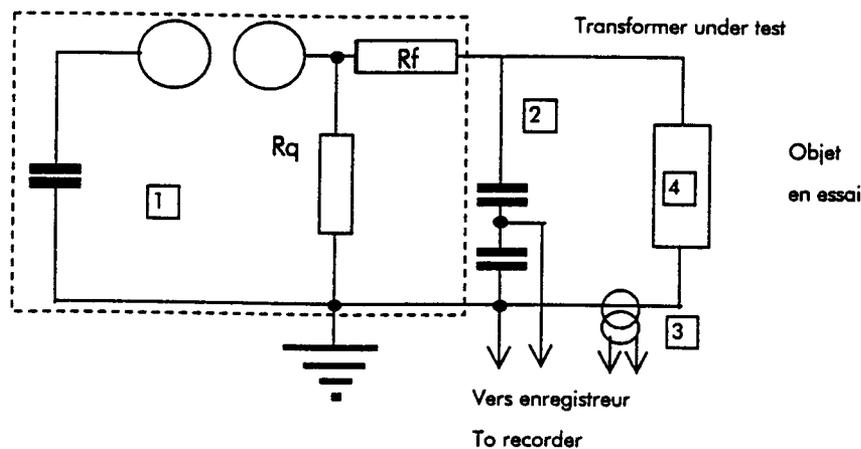
The current is measured across a wide band current transformer, and recorded.

After calibration impulses at approximately half voltage and 36.2 kV,

- 15 negative full impulses at 72.4 kV, and
- 15 positive full impulses at 72.4 kV

have been applied to the apparatus.

TEST DIAGRAM



TEST RESULTS

Examination of the impulse voltage recordings shows that no internal or external flashover has occurred.

The accuracy measurement test taken before and after the test, show that no internal puncture has occurred (see accuracy results page: 15-16).

The non-significant accuracy measurements change ensures that no puncture has occurred..
 See oscillograms in annex: 1, pages: 42 to 58.

The lightning impulse test is satisfactory.

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SHORT-CIRCUIT WITHSTAND CAPABILITY TEST

The capacitor voltage transformer under test is energized from the primary side, connected for the equivalent circuit of THEVENIN. Applied primary voltage U_p results from measured capacitance values $C1$ and $C2$.

The short-circuit is applied one time between the secondary terminal 1a-1n, and another time on the 2a-2n secondary for a duration of one second.

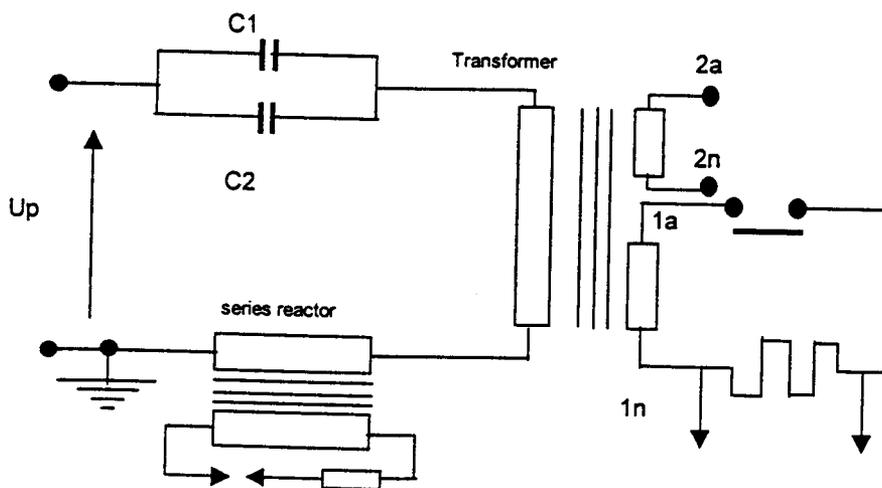
During the short-circuit, the RMS value of the applied voltage at the transformer terminals shall not be less than the rated voltage. Primary, secondary voltages and secondary current are recorded.

The transformer has passed the test if, after cooling to ambient temperature, it satisfies the following requirements :

- It is not visibly damaged.
- Its errors do not differ from those recorded before the tests by more than half the limits of error in its accuracy class.
- It withstands the dielectric a.c. tests, secondary a.c. test, but with the test voltages reduced to 90% of those given.
- On examination, the insulation next to the surface of both the primary and the secondary windings does not show significant deterioration (e.g. carbonization).

The examination d) is not required if the current density in the winding does not exceed 160 A/mm^2 where the winding is of copper of conductivity not less than 97% of the value given in IEC Publication 28.

DIAGRAM:



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TESTS VALUES & RESULTS

Test on : 1a - 1n

Rated primary voltage	Vp	220 000/√3 V
Measured capacitance	C1	4 930 pF
Measured capacitance C2	C2	66 510 pF
Rated value for $U_p = V_p \times C1 / (C1 + C2)$	Up	8 764 V
Primary voltage measured during the short-circuit:	Up	8 770 V
Measured duration of short-circuit		1.098 s
Measured current on 2a-2n during the short-circuit:		38.8 A (RMS)
Secondary winding conductor section:		6.73 mm ²
Current density in secondary winding:		5.76 A/mm ²
Calculated primary winding current during short-circuit:		0.038 A (RMS)
Primary winding conductor section:		0.0989 mm ²
Current density in primary winding:		0.383 A/mm ²
Ambient temperature		21.3 °C
Primary winding resistance at ambient temperature:		1 004
Secondary winding resistance at ambient temperature:		67.59 m Ω
Primary winding resistance after the short-circuit:		1 006
Secondary winding resistance after the short-circuit:		67.62 m Ω
Temperature rise on the primary winding:		0.5 °K
Temperature rise on secondary 1a-1n:		0.1 °K

Test on : 2a - 2n

Rated primary voltage	Vp	220 000/√3 V
Measured capacitance	C1	4 930 pF
Measured capacitance C2	C2	66 510 pF
Rated value for $U_p = V_p \times C1 / (C1 + C2)$	Up	8 764 V
Primary voltage measured during the short-circuit:	Up	8 770 V
Measured duration of short-circuit		1.12 s
Measured current on 2a-2n during the short-circuit:		38.7 A (RMS)
Secondary winding conductor section:		6.73 mm ²
Current density in secondary winding:		5.75 A/mm ²
Calculated primary winding current during short-circuit:		0.037 A (RMS)
Primary winding conductor section:		0.0989 mm ²
Current density in primary winding:		0.374 A/mm ²
Ambient temperature		21.3 °C
Primary winding resistance at ambient temperature:		1 004
Secondary winding resistance at ambient temperature:		74.19 m Ω
Primary winding resistance after the short-circuit:		1 006
Secondary winding resistance after the short-circuit:		74.25 m Ω
Temperature rise on the primary winding:		0.5 °K
Temperature rise on secondary 1a-1n:		0.2 °K

CONCLUSIONS

After test, the electromagnetic unit is not visibly damaged.
 Accuracy results and dielectric tests have been found to conform.
 The examination d) is not required.
 See oscillograms in annex 1, pages : 59-60.

The test is satisfactory

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TRANSIENT RESPONSE TEST

DESCRIPTION

The test is performed according to IEC 186 (1987) clauses 46 & 52.

The transient response test is performed on the capacitor voltage transformer connected for the equivalent circuit of THEVENIN.

Capacitors C1 and C2 of the divider are of the same construction (identical elements contained in 1 or 2 capacitor units). Their measured capacitance are:

$$C1 = 4\,930 \text{ pF}$$

$$C2 = 66\,510 \text{ pF}$$

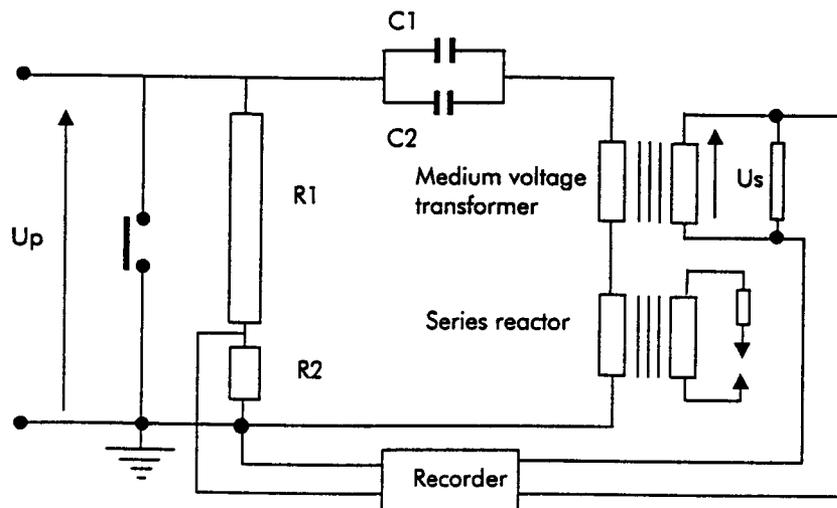
The natural frequency of this divider is higher than 1 MHz (deducted from the high-frequency capacitance and the equivalent series resistance measurements).

Thus, the main condition of IEC 186, Appendix B, allowing tests on the equivalent circuit are fulfilled.

The rated primary voltage for the equivalent circuit U_p results from measured capacitance values:

$$U_p = 127\,000 \times (4\,930 / (4\,930 + 66\,510)) = 8764 \text{ Volt.}$$

DIAGRAM:



A synchronous closer ensures the short-circuiting of the high voltage at the zero passage or at the peak of the primary voltage.

U_p is given by a HV resistor divider ($R2/R1$).

Measurements are performed on secondary 2a-2n for protective purposes. The burdens used are of series type and have a power factor of 0.8. Secondary voltage U_s and primary voltage U_p are recorded.

The capacitor voltage transformer is operated at rated primary voltage.

The test is performed twice at the zero passage and twice at the peak of the primary voltage at 25%, 100% of rated burden and for total simultaneous burden.

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TRANSIENT RESPONSE RESULTS

Burden	18.75 VA	75 VA	75 VA (+ 75 VA)
Error 20ms after the short-circuit at zero passage	5.5 %	6.7 %	8.1 %
Error 20ms after the short-circuit at peak value	≤ 1 %	1.2 %	2.2 %

CONCLUSION

20 ms after the short-circuit, the secondary output voltage must be less than 10% of the peak value before the short-circuit.

The transient response test results are **conform** to IEC requirement:

See recordings in annex 1, pages : 61 to 71.

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FERRO-RESONANCE TEST

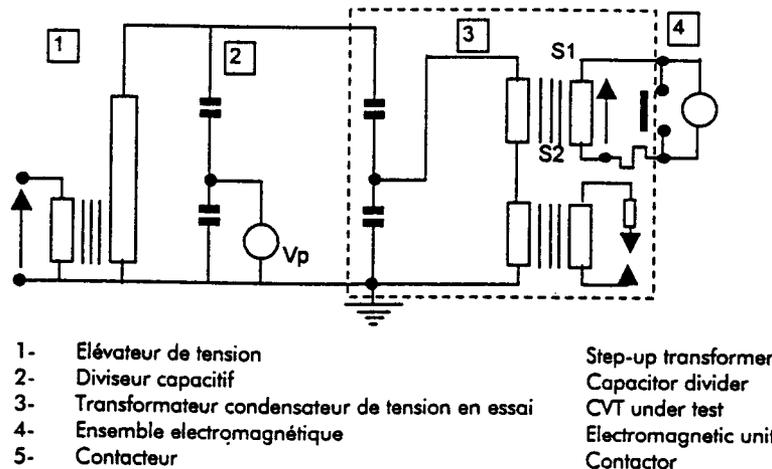
TEST CONDITIONS

The ferro-resonance test is carried out on a complete capacitor voltage transformer by short-circuiting the secondary terminals for at least 100 ms by means of a contactor.

The power source voltage U_p is recorded through a high voltage capacitive divider. During the short-circuit, the voltage of the power source does not differ by more than 10 % from the voltage before the short-circuit and remains substantially sinusoidal.

The secondary voltage V_s is recorded with a high impedance equipment which represents a burden not exceeding 5 VA.

The short-circuit current is recorded through a shunt located in series in the short-circuit loop. The impedance of the short-circuit loop is sufficiently low so that the voltage drop over it, measured directly at the secondary terminals, is less than 10 % of the voltage before the short-circuit.



TEST RESULTS

The test was performed 10 times at 80 %, and 30 times at 120 % of the rated primary voltage. 200 ms after the short-circuit is suddenly removed, the peak of the secondary voltage does not differ from its normal value by more than 10 %.

The test was repeated 10 times at 150 % of the rated primary voltage. After the short-circuit is suddenly removed, ferro-resonance does not sustain for more than 2 s.

See recordings in annex1, pages: 72 to 89.

Ferro-resonance test is satisfactory.

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TEMPERATURE RISE TEST

Apparatus under test n° : XE 91 200-01

The temperature rise test is performed on the electromagnetic unit of the capacitor voltage transformer, connected for the equivalent circuit of THEVENIN.

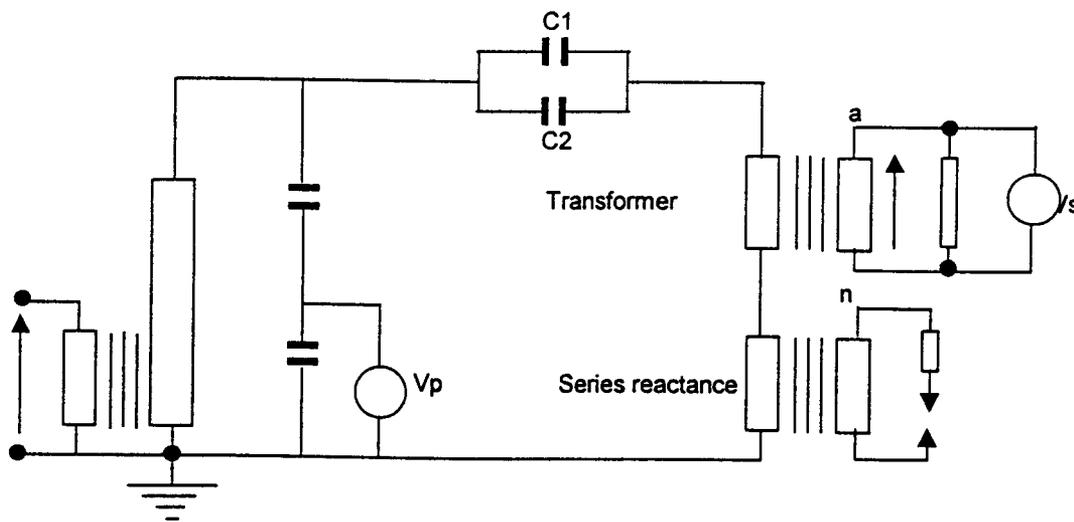
The rated primary voltage for the equivalent circuit results from measured values of capacitances C1 and C2.

$$C1 = 4\,930 \text{ pF}$$

$$C2 = 66\,510 \text{ pF}$$

$$Up = 220\,000 / \sqrt{3} \times C1 / (C1 + C2) = 8\,764 \text{ V}$$

Diagram:



The temperature rises of reactor, primary and secondary transformer windings are measured by the increase in resistance method. The oil temperature rise is measured by thermocouples.

The winding temperature rise is calculated by the following formula which includes ambient temperature variation:

$$\Delta T = (T_f - T_{ai}) = (R_f - R_i) \times (234.5 + T_{ai}) / (R_i + (T_{ai} - T_{af}))$$

The parameters are:

T_{ai} - initial ambient temperature

T_{af} - final ambient temperature

T_f - final winding temperature

R_{ai} - initial resistance of the winding

R_f - final resistance of the winding

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TEMPERATURE RISE TEST

TEST SEQUENCE

1. Measurements of resistances at ambient temperature.
2. Test at a voltage factor of 1.5 Un for 30 s with an accuracy burden, starting with cold conditions.
 Both secondaries are simultaneously loaded with their respective accuracy burden of 75 VA and 75 VA.
3. Test at a voltage factor of 1.2 Un with their respective accuracy burden, up to stable thermal conditions.
4. Test at Un with the thermal burden of 500 VA, applied to the 2a-2n secondary; this test is made continuously to the 1.2 Un test during 8 hours.

Note: Burdens are constituted of pure resistances adjusted at 44.4 Ω for 75 VA, and 8.66 Ω for the 500 VA.

RESULTS

	1 Initial values	2 1.5 Un 2 x 75VA 30s	3 1.2 Un 2 x 75VA 23 h 15 mn	4 Un 500 VA 8h	
Resistance of transformer secondary winding 1a-1n	67.59	65.79	71.38	71.85	m Ω
Resistance of transformer secondary winding 2a-2n	74.19	74.23	80.00	80.52	m Ω
Resistance of transformer primary winding	1005	1018	1105	1110	Ω
Resistance of reactor winding	407.4	407.4	426.5	425.8	Ω
Ambient temperature	21.3	21.3	19.3	20.4	$^{\circ}\text{C}$
Oil temperature	21.3	21.3	30.6	29.5	$^{\circ}\text{C}$
Temperature rise for secondary winding 1a-1n		0.7	16.3	17	$^{\circ}\text{K}$
Temperature rise for secondary winding 2a-2n		0	22.5	23.2	$^{\circ}\text{K}$
Temperature rise for primary winding		4.3	30.5	30.6	$^{\circ}\text{K}$
Temperature rise for reactor winding		0	14	12.5	$^{\circ}\text{K}$
Winding temperature rise limit		10	65	65	$^{\circ}\text{K}$
Oil temperature rise		0	11.3	9.1	$^{\circ}\text{K}$
Oil temperature rise limit		10	55	55	$^{\circ}\text{K}$

Note: According to the cooling curves, corrections for measurement delay time have been made when necessary.

Temperature rises are lower than the allowed limits.

See curves in annex 1, pages : 90-91.

The temperature rise test is satisfactory.

MEASUREMENT OF THE TRANSMISSION FACTOR OF HIGH FREQUENCY OVERVOLTAGE

Test conditions :

Low voltage impulses (U1) shall be applied between one of the primary terminals connected together and earth. The terminals of the secondary windings intended to be earthed shall be connected to the frame and to earth. The transmitted voltage (U2), shall be measured at the burden terminals using a high impedance device of bandwidth equal or higher than 100 MHz(ex : oscilloscope probe) which reads the peak value. The overvoltages transmitted to the secondary winding (Us) when the specified overvoltages (Up) is applied to the primary winding shall be calculated as follows :

$$U_s = (U_2 / U_1) \times U_p$$

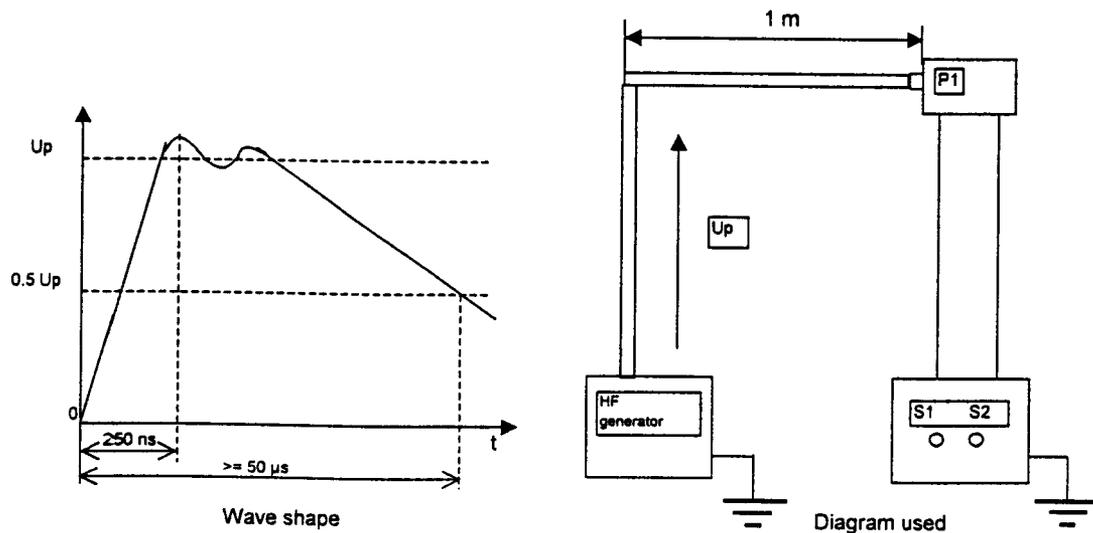
With : $U_p = (1.6 \times \sqrt{2} U_m) / \sqrt{3} = (1.6 \times \sqrt{2} \times 245000) / \sqrt{3} = 320 \text{ kV}$

And $U_s \leq 1.6 \text{ kV}$

The wave shape characteristics for capacitor voltage transformer for air-insulated substation are :

- Front time (T1) : $0.25 \mu\text{s} \pm 20 \%$
- Time to half value (T2) : $\geq 50 \mu\text{s}$
- In case of oscillations on the crest, a mean curve should be drawn, and the maximum amplitude of this curve is considered as the peak value U1 for the calculation of the transmitted voltage.

Diagram :



Result measurements :

Up primary voltage applied	Us on 1a -1n	Us on 2a -2n
300 V	0.556 V	0.632 V
Secondary HF transmitted overvoltage calculated for rated value.	1 112 V	1 264 V

Us shall be less than 1.6 kV, so the test results are satisfactory.

See oscillograms in annex 1, pages : 92-93.

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ACCURACY TEST RESULTS

Initial measurements on apparatus n° : XE 91 200-01

Appareil N° : Serial N° : Aparato N° :	Couplage et circuit Coupling and circuits Acoplamiento y Arrollamiento	Charge en VA et cos φ : 0.8 Burden in VA and Power factor Carga en VA Y cos φ : 0.8	Nombre de Un Times rated Primary Fracción de Un	Erreur de rapport en % Ratio error in % Error de relación en %	Déphasage en Minutes Phase error in minutes Desfasaje en Minutos	Observations Notes Oservaciones
XE 91 200-01	1a-1n	75 VA	75*	1.2	-0.19	+2
			1	-0.19	+2.5	
			0.8	-0.19	+3	
		75 VA	0*	1.2	+0.02	+2
			1	+0.03	+2	
			0.8	+0.03	+2.5	
	18.75 VA	0*	1.2	+0.31	+0.5	
		1	+0.32	+0.5		
		0.8	+0.32	+0.5		
	2a-2n	75	75*	1.5	-0.23	+5
				1.2	-0.17	+4.5
				1	-0.16	+5
				0.8	-0.16	+5
				0.02	-0.10	+8.5
				0.02	-0.10	+8.5
75 VA		0*	1.5	-0.03	+6.5	
			1.2	+0.05	+4	
			1	+0.05	+4	
			0.8	+0.05	+4.5	
			0.02	+0.11	+7.5	
			0.02	+0.11	+7.5	
18.75 VA	0*	1.5	+0.24	+5		
		1.2	+0.32	+1		
		1	+0.33	+1		
		0.8	+0.33	+1		
		0.02	+0.34	+3		
		0.02	+0.34	+3		

- Simultaneous burden on the other secondary winding

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ACCURACY TEST RESULTS

Measurements after lightning impulse test on apparatus n° : XE 91 200-01

Appareil N° : Serial N° : Aparato N° :	Couplage et circuit Coupling and circuits Acoplamiento y Arrollamiento	Charge en VA et cos φ : 0.8 Burden in VA and Power factor Carga en VA Y cos φ : 0.8	Nombre de Un Times rated Primary Fracción de Un	Erreur de rapport en % Ratio error in % Error de relación en %	Déphasage en Minutes Phase error in minutes Desfasaje en Minutos	Observations Notes Oservaciones
XE 91 200-01	1a-1n	75 VA	75*	1.2	-0.19	+1.5
			1	-0.19	+2	
			0.8	-0.19	+2.5	
	75 VA	0*	1.2	+0.02	+1.5	
			1	+0.03	+1.5	
			0.8	+0.03	+2	
	18.75 VA	0*	1.2	+0.31	0	
			1	+0.31	0	
			0.8	+0.32	+0.5	
2a-2n	75	75*	1.5	-0.19	+4.5	
			1	-0.14	+4	
			0.02	+0.08	+7.5	
	75 VA	0*	1.5	-0.03	+4.5	
			1	+0.05	+4	
			0.02	+0.08	+5.5	
18.75	0*	1.5	+0.27	+4		
		1	+0.33	+0.5		
		0.02	+0.32	+1.5		

- Simultaneous burden on the other secondary winding

Measurements after short-circuit test.

Appareil N° : Serial N° : Aparato N° :	Couplage et circuit Coupling and circuits Acoplamiento y Arrollamiento	Charge en VA et cos φ : 0.8 Burden in VA and Power factor Carga en VA Y cos φ : 0.8	Nombre de Un Times rated Primary Fracción de Un	Erreur de rapport en % Ratio error in % Error de relación en %	Déphasage en Minutes Phase error in minutes Desfasaje en Minutos	Observations Notes Oservaciones
XE 91 200-01	1a-1n	75 VA	75*	1.2	-0.20	+1
			1	-0.20	+1.5	
			0.8	-0.19	+2	
	75 VA	0*	1.2	+0.01	+1	
			1	+0.02	+1.5	
			0.8	+0.02	+2	
	18.75 VA	0*	1.2	+0.28	+0.5	
			1	+0.28	+0.5	
			0.8	+0.29	+0.5	
2a-2n	75	75*	1.5	-0.25	+4	
			1	-0.17	+3.5	
			0.02	-0.09	+8	
	75 VA	0*	1.5	-0.04	+4	
			1	+0.04	+3.5	
			0.02	+0.11	+6.5	
18.75	0*	1.5	+0.17	+1		
		1	+0.33	+1		
		0.02	+0.33	+2.5		

Accuracy test is satisfactory.

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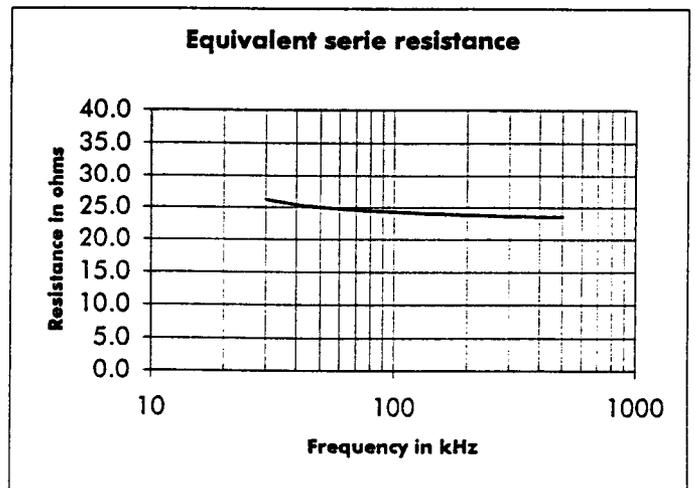
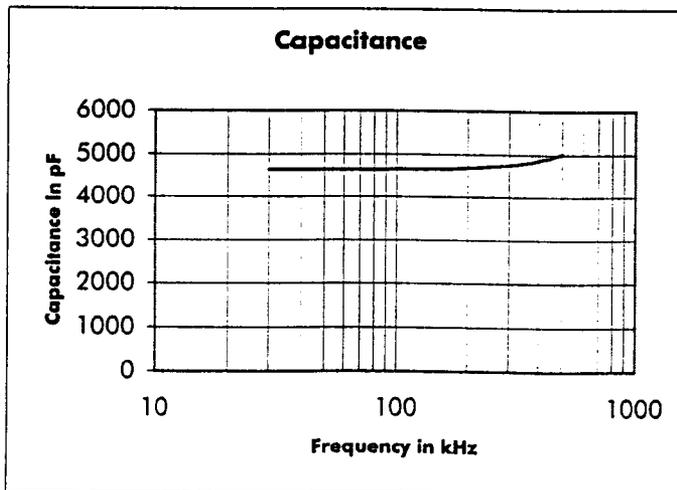
HIGH FREQUENCY CAPACITANCE AND EQUIVALENT SERIES RESISTANCE

Apparatus in test n° : XE 91 200 - 01

Measurements are taken on a complete apparatus. The measured values of the capacitance between the line and low-voltage terminals shall not deviate by more than - 20% to + 50% from the rated capacitance. The measured values of the equivalent series resistance between the same terminals shall not exceed 40 Ω at any frequency. These measurements have to be made on the carrier frequency range 30 kHz to 500 kHz.

F kHz	Cs pF	R Ω	ΔC / C %
30	4651	26.1	0
40	4653	25.3	0
50	4653	25.0	0
60	4653	24.7	0
80	4653	24.4	0.1
100	4659	24.2	0.2
150	4673	24.0	0.5
200	4697	23.8	1.0
250	4728	23.7	1.7
300	4768	23.6	2.5
333	4801	23.6	3.2
400	4877	23.5	4.9
480	4992	23.5	7.3
500	5025	23.5	8.0

The test is satisfactory



Resonance frequency

Resonance frequency is calculated from these measurements and is at least 1.85 MHz.

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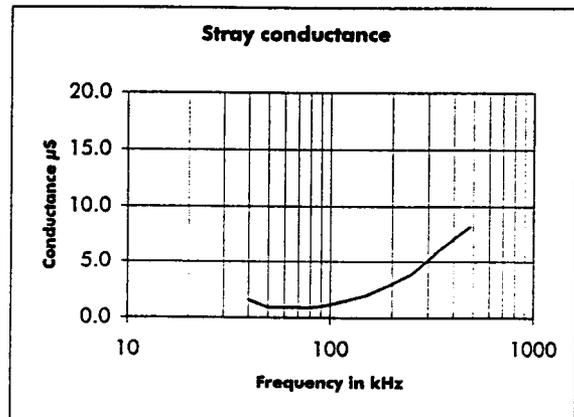
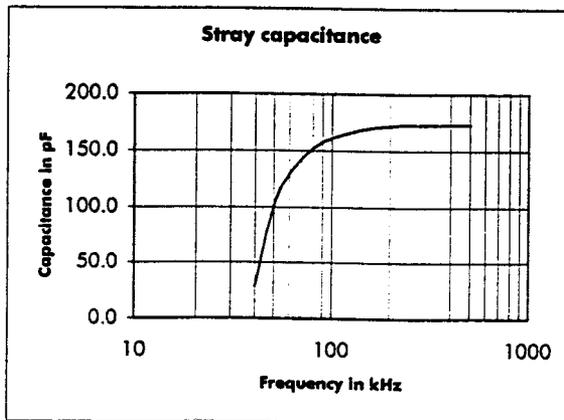
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STRAY CAPACITANCE AND STRAY CONDUCTANCE OF THE LOW VOLTAGE TERMINAL

Measurements are taken on a complete apparatus .The values of the stray capacitance and the stray conductance, measured at any frequency in the carrier frequency range, shall not exceed 200 pF and 20 μ S respectively. These measurements have to be made on the carrier frequency range 30 kHz to 500 kHz.

F kHz	Cp pF	G μ S
30	-----	-----
40	28.2	1.6
50	100.8	0.9
60	129.1	0.9
80	152.1	0.9
100	161.4	1.2
150	169.5	2.0
200	172.2	3.0
250	173.1	3.9
300	173.0	5.1
333	173.1	5.9
400	173.3	7.0
480	173.0	8.1
500	173.3	12.3

The test is satisfactory



DETERMINATION OF THE TEMPERATURE COEFFICIENT

Test is made according with IEC 358, and done on model capacitor available with the climatic encloser .
 The model is composed with 18 elements having the same clamping construction as the capacitor under consideration.
 The the applied voltage to capacitance and loss angle tangent measurement is of 16 kV and 50 Hz frequency.
 It represents % of the rated voltage of the apparatus.

Temperature measurements are :

-40 , -25, -10, +5, +20, +35, +50, +65 °C

and after thermal stablisation .

The voltage is applied to the capacitor only for the period time necessary for taking the measurements.

TEMPERATURE COEFFICIENT CALCULATION

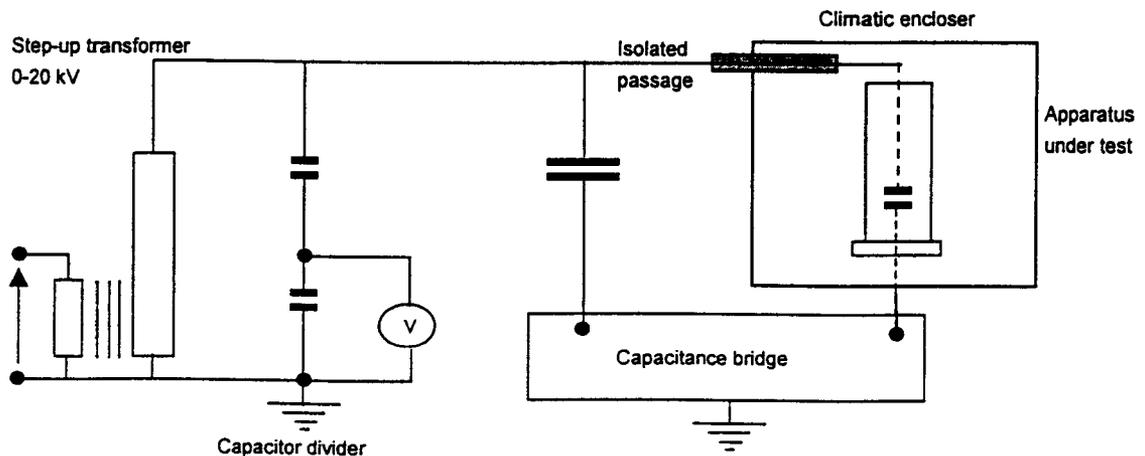
The temperature coefficient is calculated for each temperature interval Δt , according with the IEC 358 § 3.28 definition.

$$K_c = (1 / C_0) \times (\Delta C / \Delta t)$$

where : $\Delta t = T_2 - T_1$ et $\Delta C = C_2 - C_1$

- T2 : final temperature of the interval
- T1 : initial temperature of the interval
- C2 : measured capacitance at T2
- C1 : measured capacitance at T1
- C0 : measured capacitance at 20 °C

DIAGRAM USED



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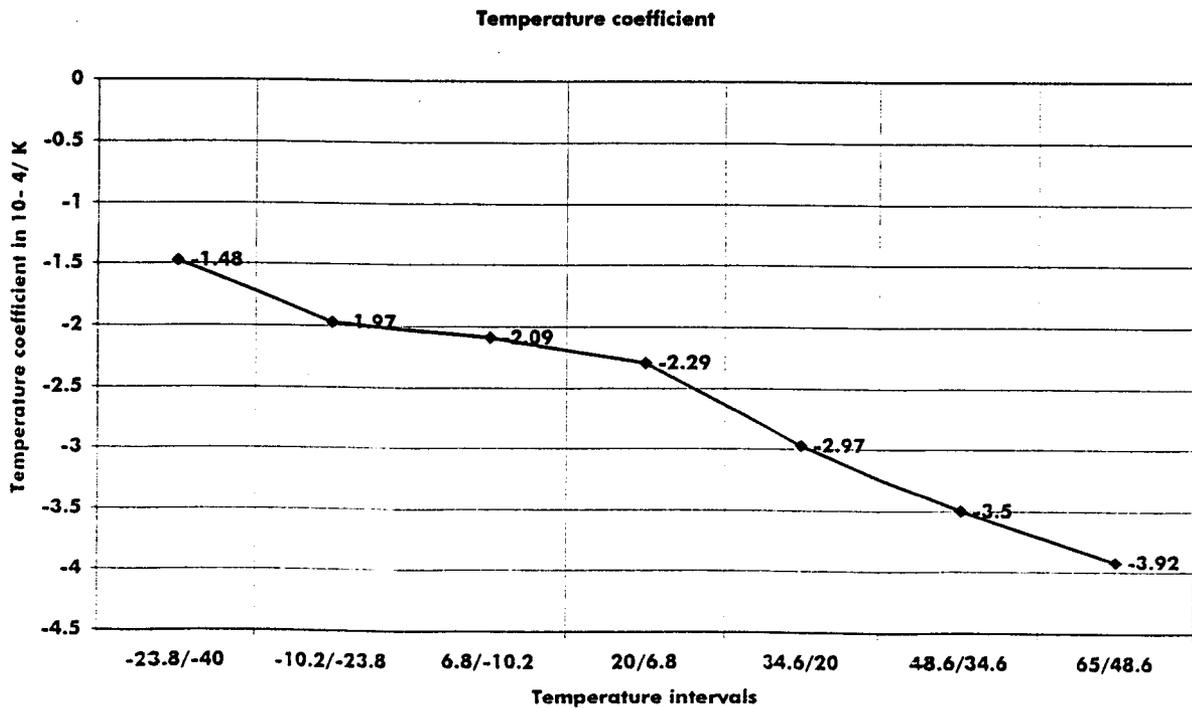
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RESULTS

U applied	10 000 V		16 000 V		
Temperature °C	Capacitance pF	Tangent δ 10-3	Capacitance (pF) pF	Tangent δ 10-3	Kc 10-4 / °C
-40	50864	1.86	50868	1.863	
-23.8	50740	1.245	50747	1.243	-1.485
-10.2	50605	0.949	50612	0.946	-1.970
6.8	50424	0.777	50433	0.770	-2.090
20	50274	0.707	50281	0.707	-2.290
34.6	50054	0.674	50063	0.652	-2.970
48.6	49804	0.693	49816	0.637	-3.500
65	49480	0.774	49493	0.715	-3.920

The temperature coefficient derived from the measurements shall not exceed $k_c \leq 0.001$ per degree Celsius.
 Test is conform .

Capacitance temperature coefficient kc variations (mesured at 16 kV (C20 = 50 281)

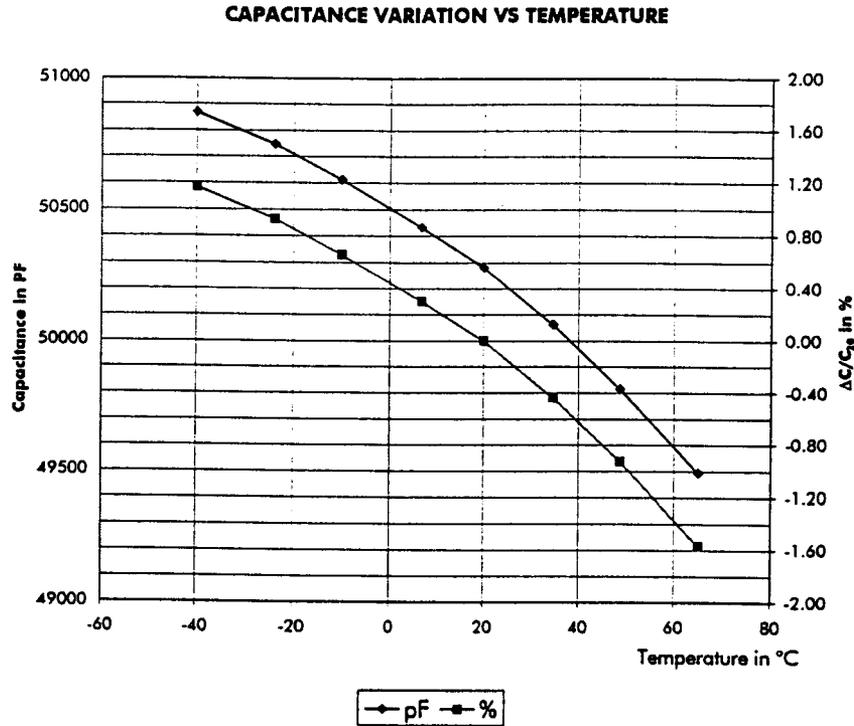


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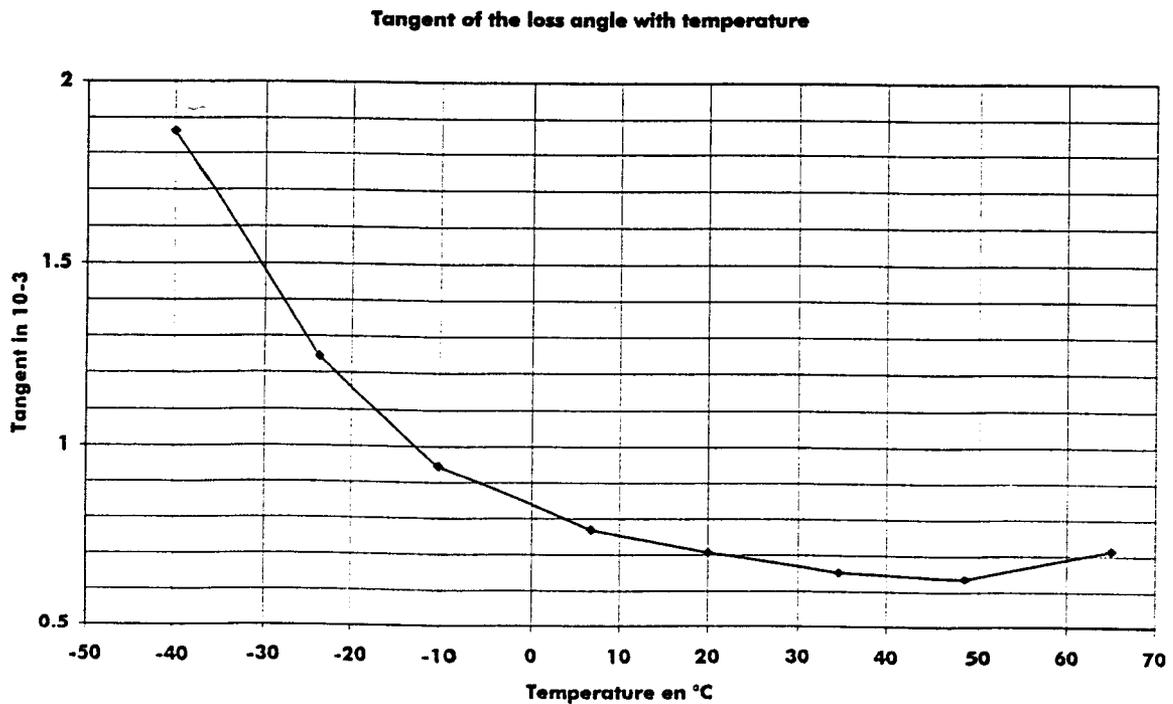
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Capacitance variations according with temperature



Loss angle variation according with temperature



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COEFFICIENT TEMPERATURE DETERMINATION

Model used to make the test :



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TIGHTNESS OF CAPACITOR VOLTAGE DIVIDER

The test is made on the capacitor voltage divider before mounting on electromagnetic unit .
Pressure applied of 1 ± 0.1 bar above the the operating pressure, is maintained during 8 hours inside the capacitor voltage divider .

After this time there is no evident leakage on the electromagnetic unit so the test is satisfactory.

