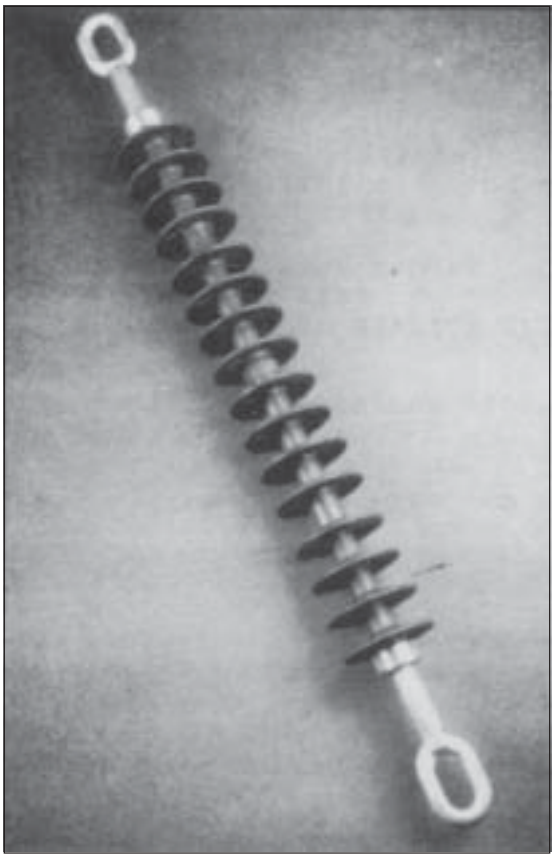
IEC 1109
Design Test Report
Ohio Brass Hi*Lite XL



This design test report records the results of laboratory tests made on the Ohio Brass Hi*Lite XL Suspension Insulators.

Test performed in accordance with IEC Standard 1109, clause 5 and Annex C.

The Hi*Lite XL Suspension Insulators meet all applicable requirements of these standards.

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HUBBELL® POWER SYSTEMS, INC.

OHIO BRASS®

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NOTE: Because Ohio Brass has a policy of continuous product improvement, we reserve the right to change design and specifications without notice.

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EU1348-HR
A&J 10/97

client	OHIO BRASS c.o. - Wadsworth - U.S.A.
equipment under test	Hi*Lite XL suspension composite insulators: No. 17 samples 25k SML (cat. No.411205-1004), No. 26 samples 50k SML (cat. No. 413205-1301) and two special samples for each rod size.
tests performed	**Design test report IEC 1109 OHIO BRASS HI*LITE XL.**
normative documents	IEC Pubblication 1109, 1992.
test date	From October 1993 to April 1994
notes	

no of pages	15
issue date	July 4th, 1994.

prepared	A. TOMBA - LAB	
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Annexed reference documents

- CESI Prot.No. 94/002789
- CESI Prot.No. 94/002790
- CESI Prot.No. 94/002791
- CESI Prot.No. 94/002792
- CESI Prot.No. 94/002794
- CESI Prot.No. 94/002795
- CESI Prot.No. 94/013189
- CESI Prot.No. 94/002796

Reference documents

- CESI Prot.No. 93/030284, 93/028389 test report
- CESI Prot.No. 93/030283, 94/013180 inspection report.
- CESI Prot.No. 93/027942, rapporto di prova

Test witnessed by

Michael G. COMBER - Ohio Brass - Wadsworth - U.S.A.

NOTE : All the records and test objects have been delivered to the Client.

Keywords: 12015R 22342W 31020W 41040M 51050V 62620J 62501B

1 - TEST OBJECTS

1.1 - No. 17 samples 5/8" diameter (16 mm) rod insulator (catalog no.411205-1004); henceforth referenced as 25k SML samples. The insulators were named unit A,B,C,D,E,F,G,H,K, L and unit 1,2,3,4,5,6,7, for the first and second lot respectively.
The drawings of the samples are given in the annexed reference documents: CESI Ref. No. 94/002791 and 94/002792.
A picture of the object is shown in page 11.

1.2 - No 26 samples 7/8" diameter (22 mm) rod insulator (catalog no. 413205-1301); henceforth referenced as 50k SML samples. The insulators were named unit M,N,P,Q,R,S,T,U,V, W, unit 8,9,10,11,12,13 and 21,22,23,24,25,26,27,28,29,30 for the first, second lot and third lot, respectively.
The drawings of the samples are given in the annexed reference documents: CESI Ref. No. 94/002789, 94/002790 and 94/013189.
A picture of the object is shown in page 12.

1.3 - No 2 special samples for each rod size.
These are referenced as 25k SML and 50k SML special samples for the 5/8"and 7/8" rod diameter types, respectively. The samples were named unit J,Y and Z,X for the 25k SML and 50k SML special samples, respectively.
The drawings of the samples are given in the annexed reference documents: CESI Ref. No. 94/002794 and 94/002795.
A picture of the object is shown in page 13.

2 - TEST OBJECT RECOGNITION: partially made

The test object recognition has been made on the basis of the dimensions give on the drawings supplied by the Client.

No chemical or physical analyses were made.

The test objects are truly conform to the certified drawings of their type supplied by the Client.

This drawings stamped and numbered by CESI with 94/002791, 94/002792, 27/002789, 94/002790, 94/013189, 94/002794 and 94/002795 are annexed to this report.

3 - TESTS PERFORMED AND TESTING PROCEDURES

The objects in item 1 were submitted to tests as specified in the Ohio Brass CO Specification for Design Test Performance to IEC 1109 [1]. The tests were carried out in accordance with the requirements given in the relevant Sub-clauses.
The subject Specification has been annexed to the test report - see reference document CESI LAB-94/002796. The performed tests and the adopted testing procedures are described in the following sections.

3.1 - Tests on interfaces and connections of metal fittings - see Sub-clause 5.1 of [1].

Three samples each of object in item 1.1 and 1.2 have been tested in each of the following sections, as specified in Sub-clause 5.1.1 of [1]. The tests were carried out on the units named A,B,C and M,N,P for the insulator rod type 25k SML and 50k SML, respectively.

3.1.1 - Dry power frequency voltage test - see Sub-clause 5.1.2 of [1]

3.1.2 - Prestressing - see Sub-clause 5.1.3 of [1].

3.1.2.1 - Sudden load relase test - see Sub-clause 5.1.3.1 of [1].

3.1.2.2 - Thermal-mechanical test - see Sub-clause 5.1.3.2 of [1].

3.1.2.3 - Water immersion test - see Sub-clause 5.1.3.3 of [1].

3.1.3 - Verification tests - see Sub-clause 5.1.4 of [1].

3.1.3.1 - Visual examination - see Sub-clause 5.1.4.1 of [1].

3.1.3.2 - Steep-front impulse voltage tet - see Sub-clause 5.1.4.2 of [1].

3.1.3.3 - Dry power frequency voltage test - see Sub-clause 5.1.4.3 of [1].

3.2 - Assembled core load-time test - see Sub-clause 5.2 of [1].

Six samples each of object in item 1.1 and 1.2 have been tested, as specified in Sub-clause 5.2.1 of [1]. The tests were carried out on the units named H,K,2,3,6,7 and 22,23,24,25,26,27 for the insulator rod type 25k SML and 50k SML, respectively.

3.2.1 - Determination of average failing load of the core of the assembled insulator - see Sub-clause 5.2.2.1 of [1].

The tests were carried out on the units named 2,3,6 and 22,23,24 for the insulator rod type 25k SML and 50k SML, respectively.

3.2.2 - Control of the slope of the strenght-time curve of the insulator - see Sub-clause 5.2.2.2 of [1].

The tests were carried out on the units named H,K,7 and 25,26,27 for the insulator rod type 25k SML and 50k SML, respectively.

3.3 - Test of the housing: tracking and erosion test - see Sub-clause 5.3 of [1].

Two special samples of each rod size object in item 1.3 have been tested as specified in Sub-clause 5.3.1 of [1]. The tests were carried out on the samples named J,Y and X,Z for the insulator rod type 25k SML and 50k SML, respectively. The samples Y,X and J,Z were tested in horizontal and vertical arrangement respectively.
The tests were carried out in accordance with the requirements given in Sub-clause 5.3.1, 5.3.2 and 5.3.3 of [1].
During the tests, the samples were energized at 16 kV (equal to about a specific creepage distance of 20 mm/kV).

The test duration was equal to 1,000 hours.

3.4 - Tests for the core material - see Sub-clause 5.4 of [1].

Samples of each rod size of the object in item 1.1 and 1.2 have been tested.

3.4.1 Dye penetration test - see Sub-clause 5.4.1 of [1].

Ten core material samples of each rod size have been tested. The samples, prepared as specified in Sub-clause 5.4.1.1 of [1], were obtained from the units named L and W for the insulator rod type 25k SML and 50k SML, respectively.
The tests were carried out in accordance with the requirements given in Sub-clause 5.4.1.2 of [1].

3.4.2 Water diffusion test - see Sub-clause 5.4.2 of [1]

Six core material samples of each rod size have been tested. The samples, prepared as specified in Sub-clause 5.4.2.1 of [1], were obtained from the units named L and W for the insulator rod type 25k SML and 50k SML, respectively.

The tests were carried out in accordance with the requirements given in Sub-clauses 5.4.2.2 and 5.4.2.3 of [1].

4 - TEST RESULTS

4.1 - Tests on interfaces and connections of metal fittings - see item 3.1.

The detail about the adopted testing techniques and the obtained results are given in CESI reference documents: LAB-93/027942 and LAB-93/030283.

4.1.1 - Dry power frequency voltage test - see item 3.1.1.

The individual flashover voltages and the averaged value, obtained on the objects of both 25k SML and 50k SML types, are given in the following Table I.

Table I - Dry power frequency flashover voltage determined before the test sequence.

TYPE/N	Vs 1 (kV)	Vs 2 (kV)	Vs 3 (kV)	Vs 4 (kV)	Vs 5 (kV)	Vmcor (kV)
25k/A	356.3	357	363.3	363.3	362.6	365.6
25k/B	358.4	357	358.4	359.8	361.9	364.1
25k/C	364.7	358.4	361.2	361.2	361.9	365.7
50k/M	352.8	354.2	354.9	354.9	354.9	359.9
50k/N	350.7	352.8	361.2	357.7	357.7	360.6
50k/P	356.6	351.4	348	351.4	356.6	357.4

Note: Vmcor - average of 5 corrected flaschover values of each samples, calculated and recorded according to [2-3].

4.1.2 - Prestressing - see item 3.1.2.

4.1.2.1 - Sudden load relase test - see item 3.1.2.1

Five sudden load release with the object at -25°C were made on each tested object from a tensile load equal to 0.3 SML, namely:
- 7,500 lbs (34 kN) for the 25k SML units;
- 15,000 lbs (68 kN) for the 50k SML units.

Test results: **satisfactory** - no mechanical failure and surface modifications were observed for all tested objects.

4.1.2.2 - Thermal-mechanical test - see item 3.1.2.2.

A tensile load equal to 0.5 SML was applied continuosly to the tested objects, namely:
- 12,500 lbs (56.7 kN) for the 25k SML units;
- 25,000 lbs (113.4 kN) for the 50k SML units.

Test results: **satisfactory** - no mechanical failure, surface modifications and insulator lengthning were observed for all tested objects.

4.1.2.3 - Water immersion test - see item 3.1.2.3.

The objects of both 25k and 50k SML types were immersed in boiling water, as specified, for 42 h.

4.1.3 - Verification tests - see item 3.1.3.

4.1.3.1 - Visual examination - see item 3.1.3.1.

Test results: **satisfactory** - no surface modification were observed for all tested objects.

4.1.3.2 - Steep-front impulse voltage tet - see item 3.1.3.2

The objects of both 25k SML and 50k SML types were submitted to impulse voltage with a steepness equal to at least 1000 kV/μs.

Test results: **satisfactory** - each impulse caused external flashover between the electrodes, no puncture and surface modification were observed for all tested objects.

4.1.3.3 - Dry power frequency voltage test - see item 3.1.3.3.

The individual flashover voltages and the averaged value, obtained on the objects of both 25k SML and 50k SML types, are given in the following Table II. The power frequency withstand voltage applied to each tested object and the relevant results are given in Table III.

Table II - Dry power frequency flashover voltage determined at the end of the test sequence.

TYPE/N	Vs 1 (kV)	Vs 2 (kV)	Vs 3 (kV)	Vs 4 (kV)	Vs 5 (kV)	Vmcor. (kV)
25k/A	332.5	329	329	336	332.5	341.4
25k/B	332.5	329	336	332.5	332.4	342
25k/C	329	336	329	332.5	329	340.6
50k/M	336	336	336	332.5	329	343.5
50k/N	322	332.5	332.5	332.5	329	339.2
50k/P	329	332.5	329	332.5	329	340

Note: Vmcor - average of 5 corrected flaschover values of each samples, calculated and recorded according to [2-3].

Table III - Dry power frequency withstand voltage determined at the end of the test sequence.

TYPE/N	Vs (kV)	time (min)	result
25k/A	285.5	30	withstand
25k/B	285	30	withstand
25k/C	278	30	withstand
50k/M	274	30	withstand
50k/N	274	30	withstand
50k/P	272	30	withstand

Note: The insulator surface temperature measurements were made with termovision techniques in two faces. The temperture rise of the shank was not more than 20 K

Test results: satisfactory - no surface modification, no puncture and no temperature rise of the shank were observed for all tested insulators.

4.2 - Assembled core load-time test - see item 3.2

The detail about the adopted testing techniques and the obtained results are given in CESI reference documents: LAB-93/030283 and LAB-94/013180.

4.2.1 - Determination of average failing load of the core of the assembled insulator - see item 3.2.1.

The failing load value obtained on each tested insulator units is given in the following Table IV. The averaged failing load value for each insulator type was as follows:
- 28,790 lbs (130.6 kN) for the 25k SML units;
- 57,080 lbs (258.76 kN) for the 50k SML units.

4.2.2 - Control of the slope of the strenght-time curve of the insulator - see item 3.2.3.

A tensile load equal to 0.6 the determined average failing load was applied continuosly to the tested objects, namely:
- 17,284 lbs (78.32 kN) for the 25k SML units;
- 34,248 lbs (155.26 kN) for the 50k SML units.

Test results: satisfactory - no mechanical failure (breakage or complete pull out) and surface modification were observed for all tested objects.

4.3 - Test of the housing: tracking and erosion test - see item 3.3

The detail about the adopted testing techniques and the obtained results are given in CESI reference document: LAB-93/028389.

The data recorded during the complete test sequence and the results of the visual examination on the tested objects are given in the following:
- The maximum leakage current value recorded during the test was 105, 130, 135 and 100 mA for the unit named J, Y, Z and X, respectively;
- The tested objects withstood during the whole test duration of 1,000 hours;
- No overcurrent trip-out occurred for each tested object;
- The erosions noted at the end of the tests were not significant and the erosion did not reach the glass-fibre core;
- No punctures on the sheds were observed.

Pictures of the tested objects are shown in pages 14 and 15.

Test results: satisfactory for all tested objects.

4.4 - Tests for the core material - see item 3.4

The detail about the adopted testing techniques and the obtained results are given in CESI reference document: LAB-93/030284.

4.4.1 Dye penetration test - see item 3.4.1.

The dye did not rise through the core by capillarity on the material samples of both 25k SML and 50k SML rod size types, for a testing period of 15 min,

Test results: satisfactory for the core material of both insulator types.

4.4.2 Water diffusion test - see Item 3.4.2.

The data recorded during the complete test sequence and the results of the visual examination on the tested objects are as follows:
- No puncture or surface flshover occurred during the tests on the material samples of both 25k SML and 50k SML rod size types;
- The maximum current value recorded during the whole test did not exceed 15 and 130 μA on the material samples of the 25k SML and 50k SML rod size type, respectively.

Test results: satisfactory for the core material of both insulator types.

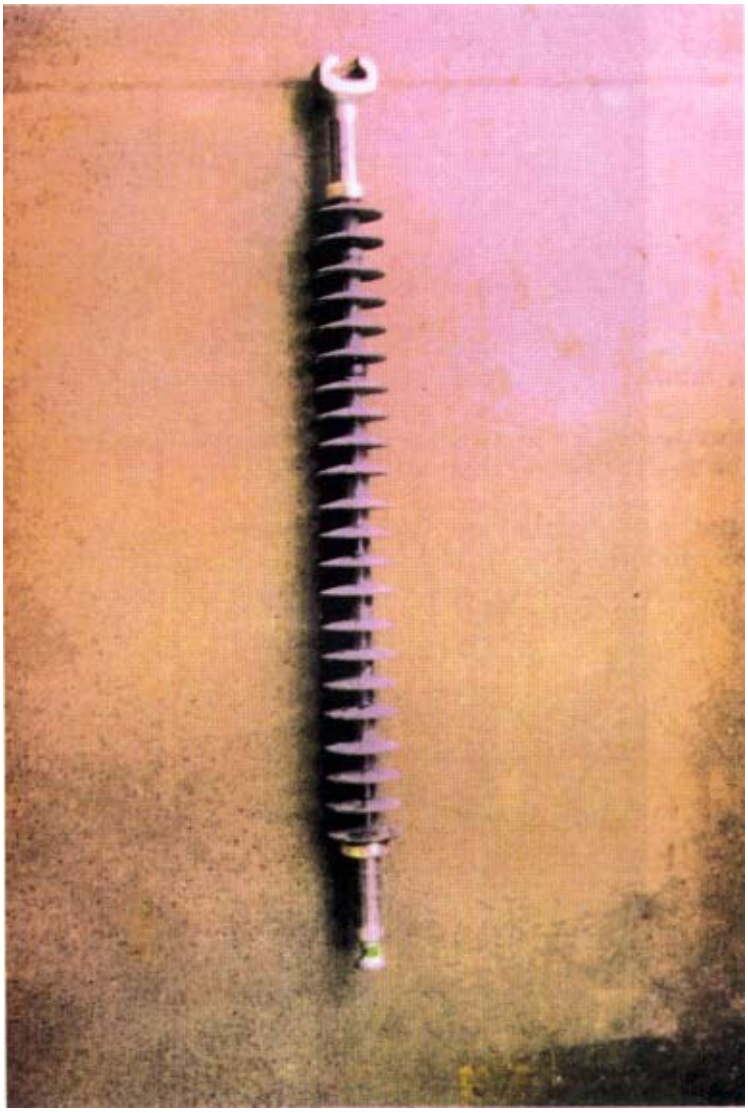
5. REFERENCE

[1] - THE OHIO BRASS CO. SPECIFICATION FOR DESIGN TEST PERFORMANCE TO IEC 1109.

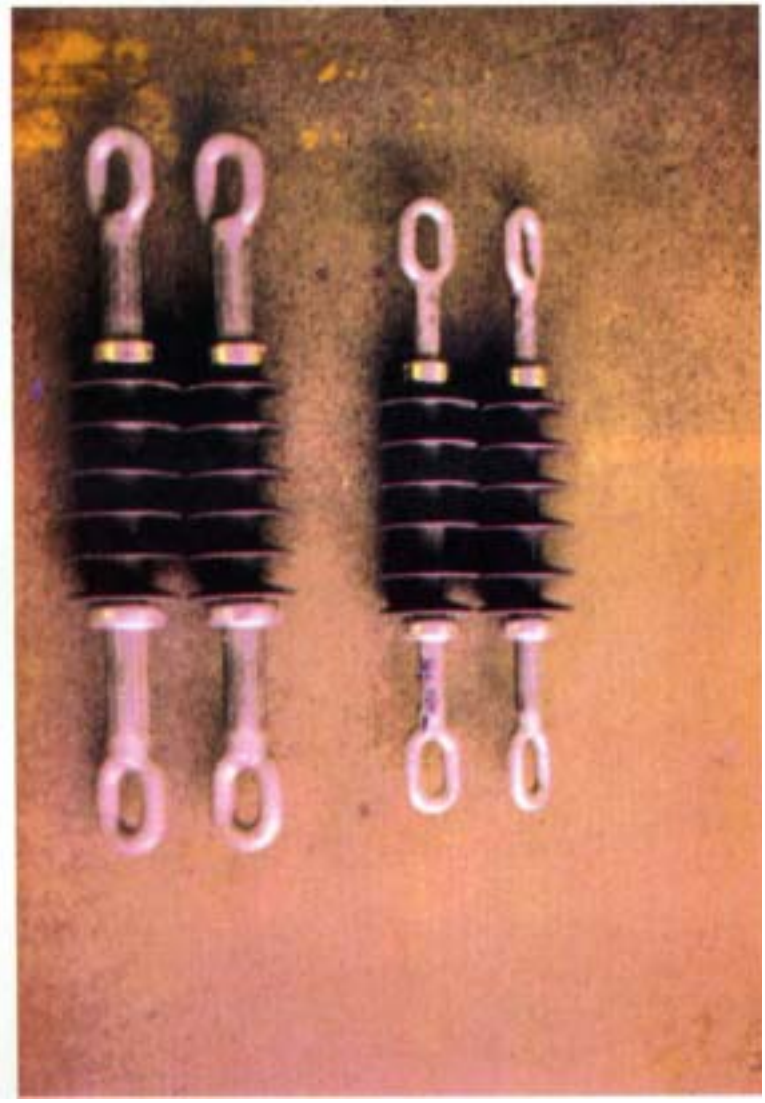
[2] - IEC Publication 1109: "Composite insulators for a.c. overhead lines with a nominal voltage greater than 1000 V - Definitions, test methods and acceptance criteria"; 1992.

[3] - IEC Publication 60-1: "High-voltage test techniques - Part 1: General definitions and test requirements'; 1989.

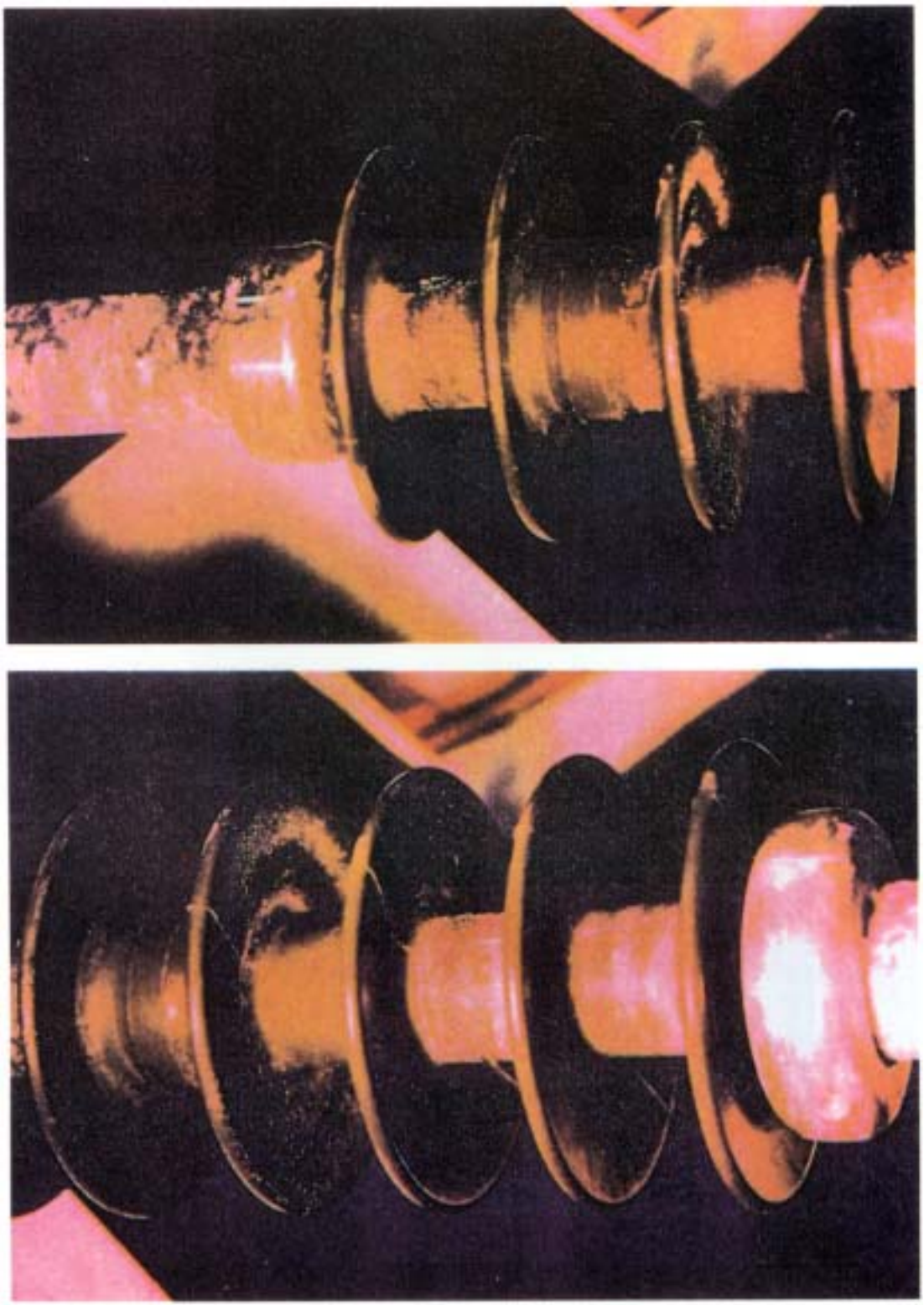
Picture 1 : composite insulator type 25k SML, No. 421205/1004.



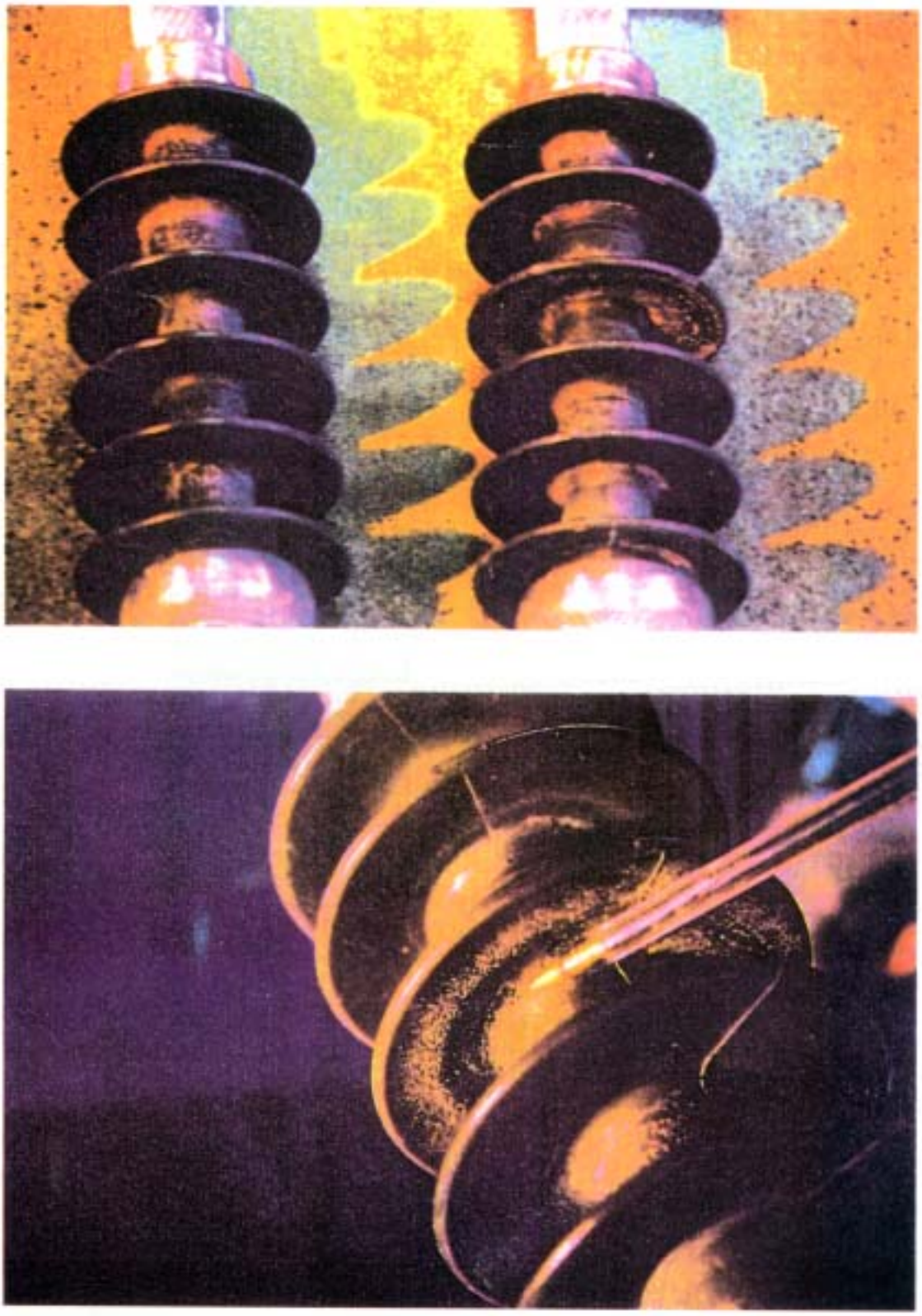
Picture 2 : composite insulator type 50k SML, No. 423205/1301.



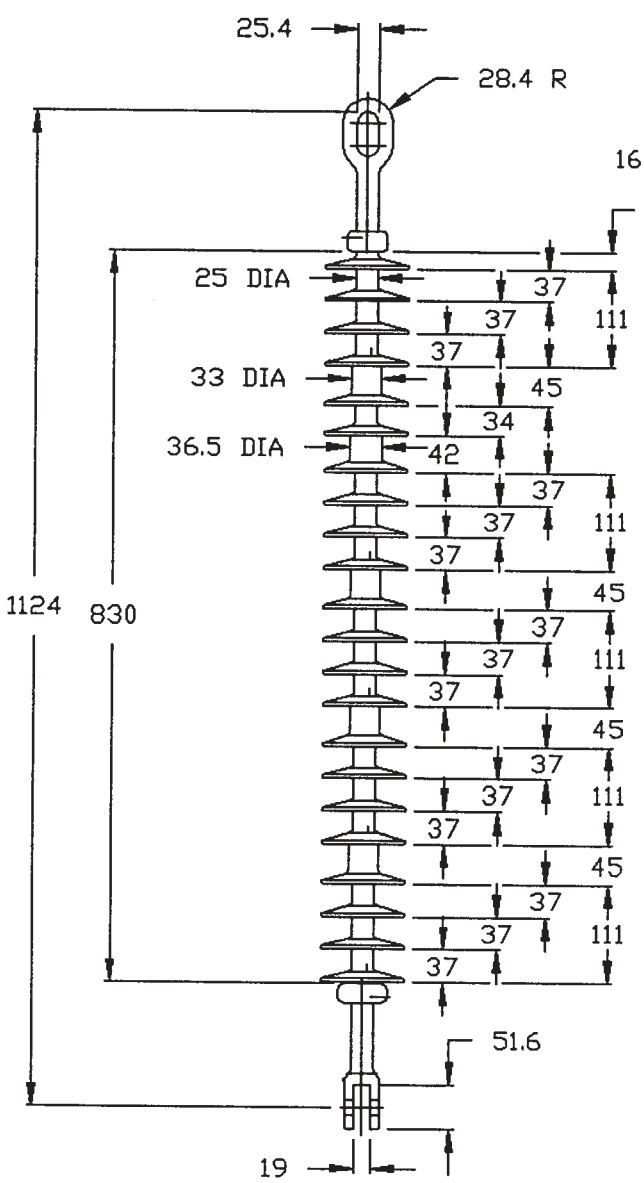
Picture 3 : No. 2 special samples of composite insulator type 50k SML, No. 423205/1301, and No. 2 special samples of composite insulator type 25k SML, No. 411205/1004.



Picture 4 : special samples of composite insulator type 50k SML, No. 423205/1301, at the end of the traking and erosion tests of 1,000 hours, no puncture of weathersheds shall be noted.



Picture 5 : special samples of composite insulator type 25k SML, No. 411205/1004, at the end of the traking and erosion tests of 1,000 hours, no puncture of weathersheds shall be noted.



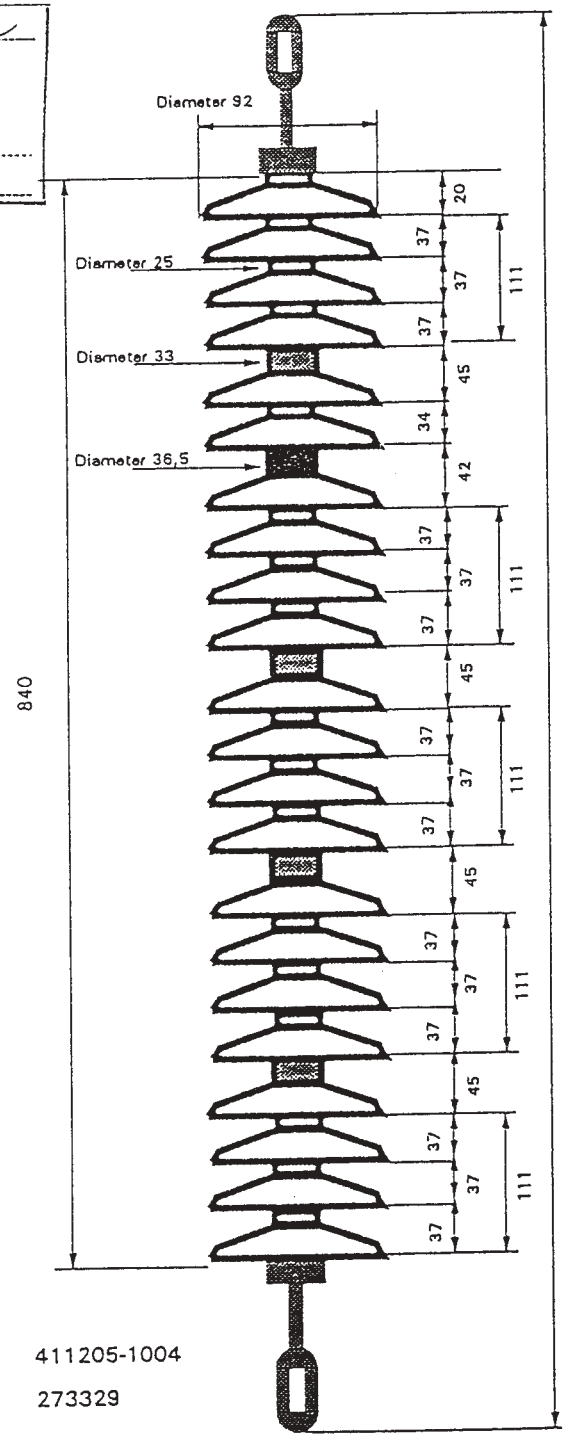
STRIKE DISTANCE	830mm
LEAKAGE DISTANCE	2134mm
DRY 60 HZ FLASHOVER	340 KV
WET 60 HZ FLASHOVER	320 KV
IMPULSE CRITICAL POSITIVE	555 KV
IMPULSE CRITICAL NEGATIVE	540 KV
SPECIFIED MECHANICAL LOAD	111 kN
ROUTINE TEST LOAD	56 kN
WEIGHT	2.6 kg

METRIC DIMENSIONS UNLESS OTHERWISE NOTED

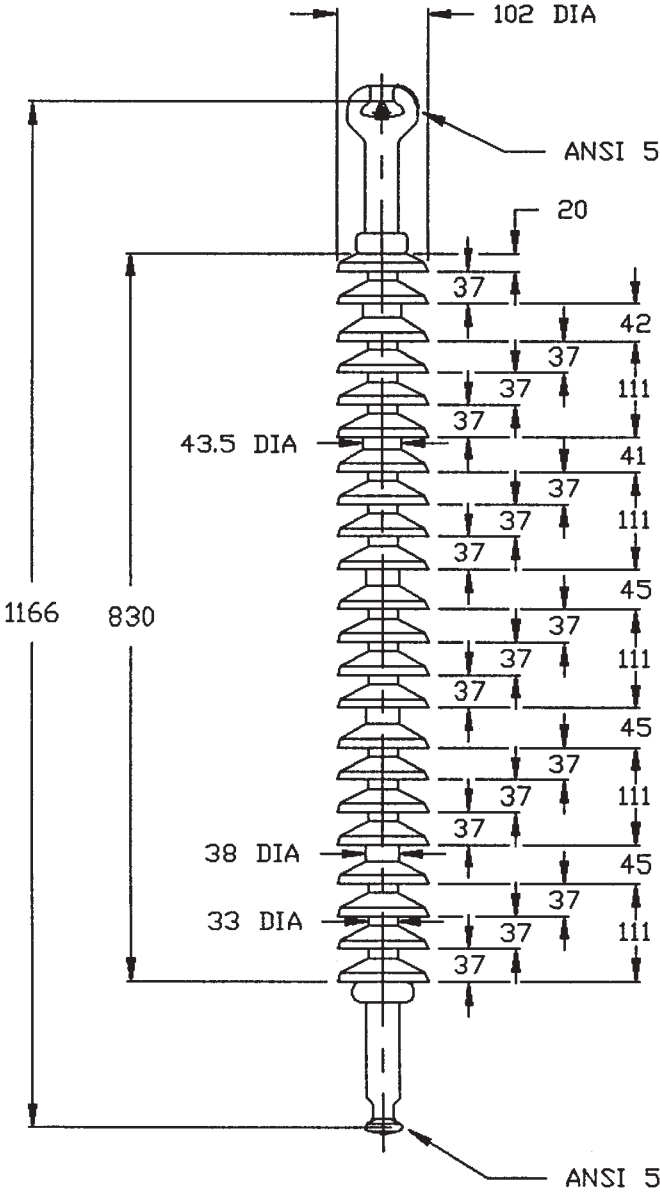
HUBBELL/THE OHIO BRASS CO.

8711 WADSWORTH ROAD, WADSWORTH, OHIO

PART NAME: HI LITE SUSP INSULATOR / 411205-1004				SCALE .12=1
DESIGN: RAB	DATE: 11/29/93	DWG. NO. S006933-00		REV. NO. 00
DRAWN: JVR	DATE: 11/29/93			



Drawing Number:	411205-1004
Electrode Number:	273329
Leakage distance:	2134mm
Arcing distance:	830mm
N.of Weathersheds:	22



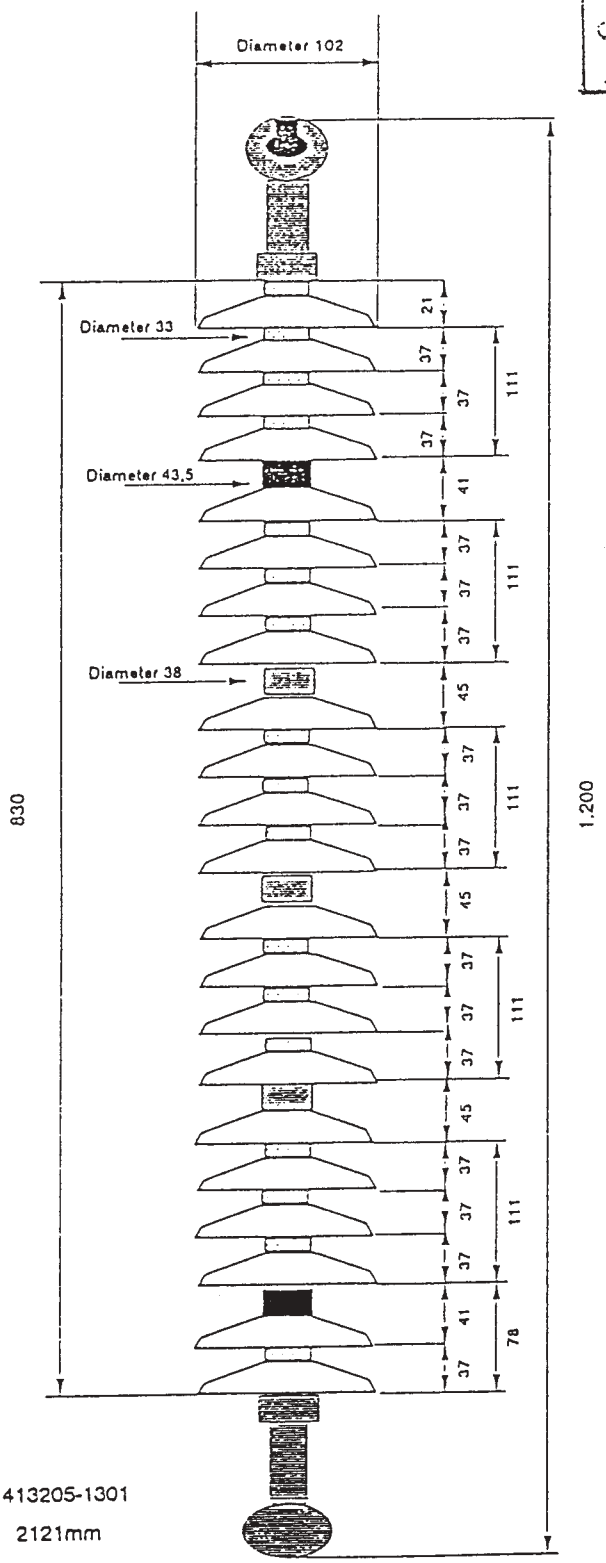
SPECIFIED MECHANICAL LOAD - 222 kN
ROUTINE TEST LOAD RATING - 111 kN
NUMBER OF WEATHERSHEDS - 22
DRY ARDING DISTANCE - 830 MM
LEAKAGE DISTANCE - 2121 MM
60 Hz DRY FLASHOVER - 340 kV
60 Hz WET FLASHOVER - 320 kV
POSITIVE IMPULSE CRITICAL - 555 kV
NEGATIVE IMPULSE CRITICAL - 540 kN
WEIGHT - 5.2 kg

METRIC DIMENSIONS UNLESS OTHERWISE NOTED

HUBBELL/THE OHIO BRASS CO.

8711 WADSWORTH ROAD, WADSWORTH, OHIO

PART NAME	HI LITE SUSP INSULATOR 413205-1301			SCALE .12=1
DESIGN	RAB	DATE 11/29/93	DWG. NO. S006931-00	REV. NO. 00
DRAWN	JVR	DATE 11/29/93		

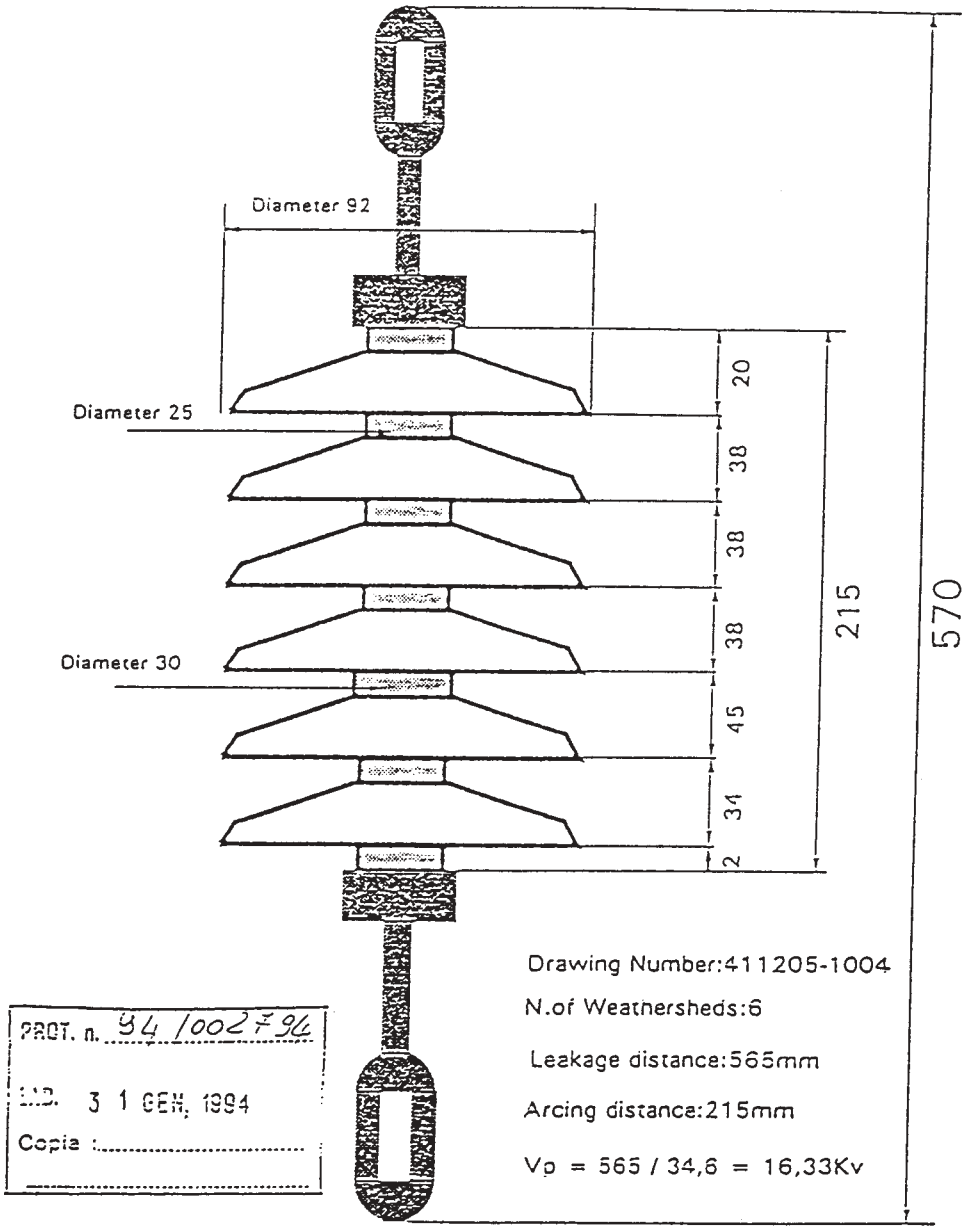


Drawing Number: 413205-1301

Leakage distance: 2121mm

Arcing distance: 830mm

N.of Weathersheds: 22



Drawing Number:411205-1004

N.of Weathersheds:6

Leakage distance:565mm

Arcing distance:215mm

Vp = 565 / 34,6 = 16,33Kv

PROT. n. 94/1002/94

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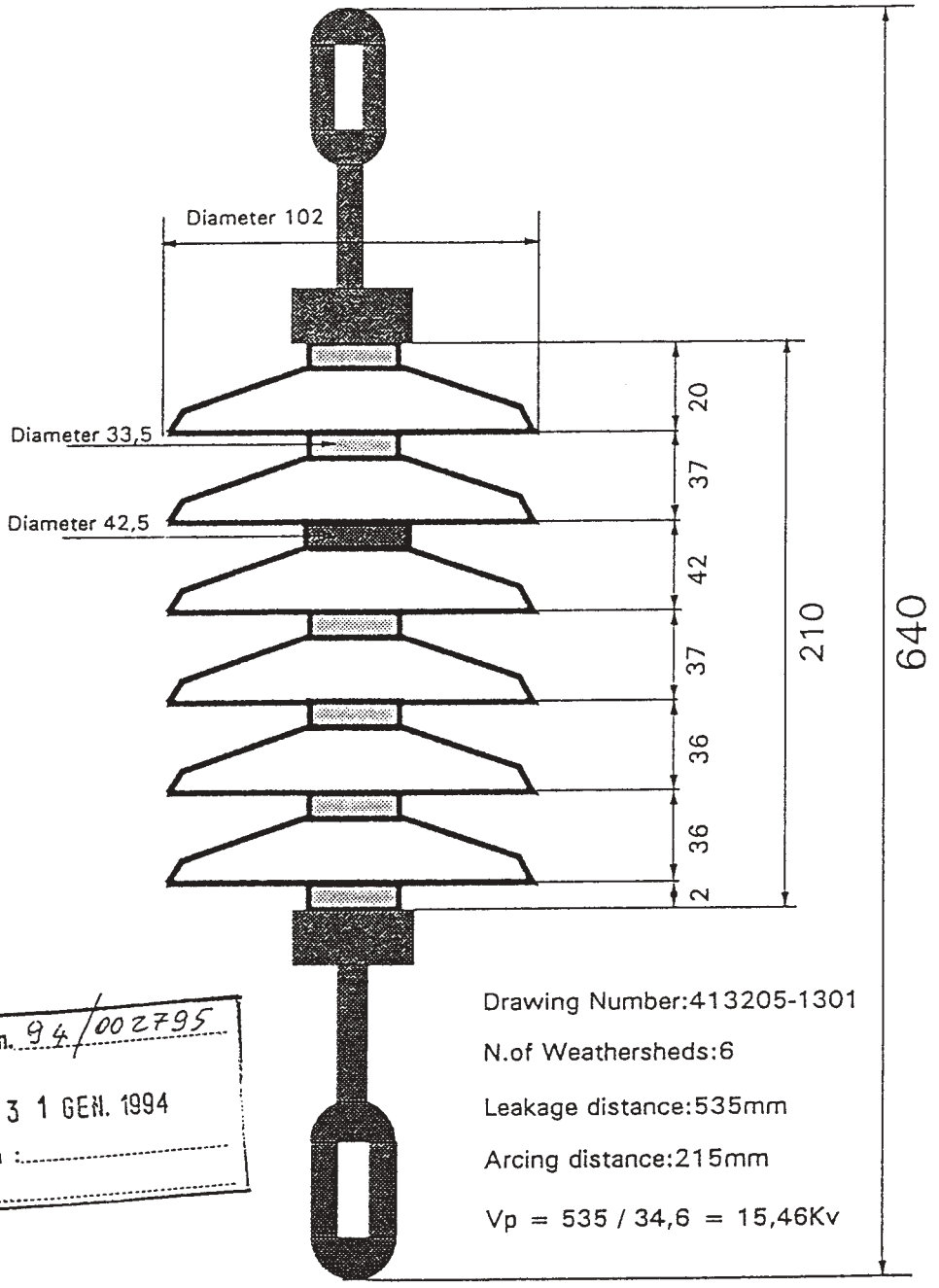

PROT. n. 94/002795

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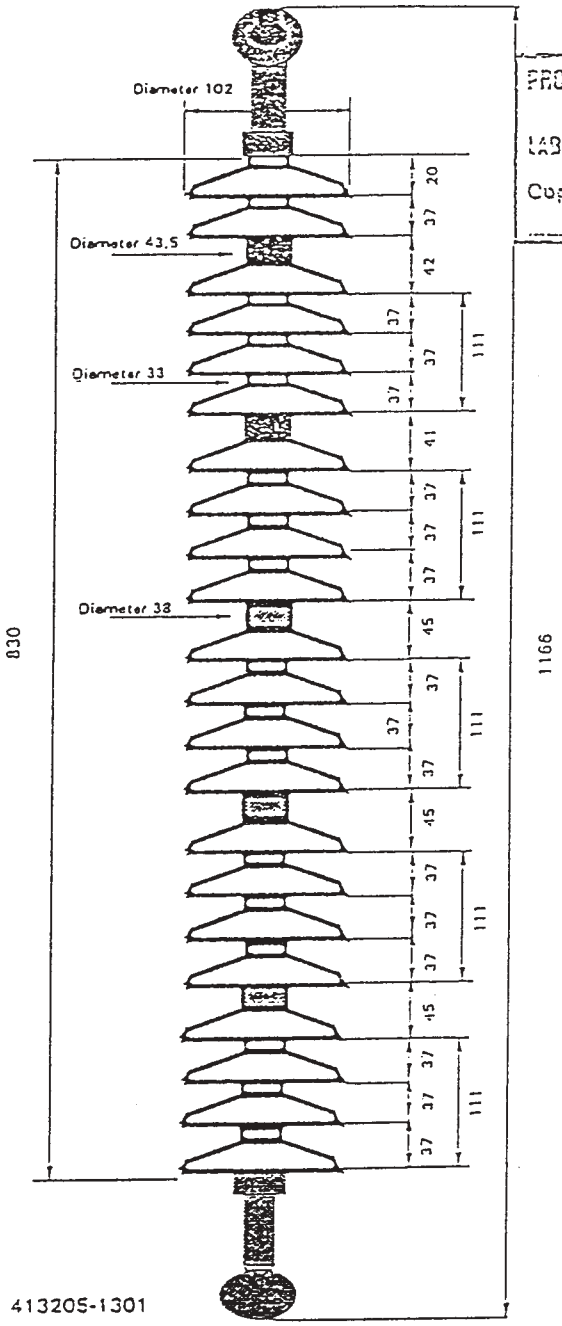
Drawing Number:413205-1301

N.of Weathersheds:6

Leakage distance:535mm

Arcing distance:215mm

Vp = 535 / 34,6 = 15,46Kv



Drawing Number: 413205-1301
Electrode Number: 52-11 273341
Leakage distance: 2121mm
Arcing distance: 830mm
N.of Weathersheds: 22

THE OHIO BRASS CO. SPECIFICATION FOR DESIGN TEST PERFORMANCE TO IEC 1109

1. SCOPE

This specification concerns test procedures to be employed for Hi*Lite XL suspension insulators. The test programs are intended to comply with the requirements of IEC 1109, section 5.

2. SAMPLES

Samples for the test program will be supplied by Ohio Brass Co.

Ten samples of a 5/8" diameter (16 mm) rod insulator (catalog no. 411205-1004; henceforth referenced as 25k SML samples) and ten samples of a 7/8" diameter (22 mm) rod insulator (catalog no. 413205-1301; henceforth referenced as 50k SML samples) shall be utilized for sections 5.1, 5.2 and 5.4. Three samples of each type shall be tested in 5.1, and six in 5.2. The samples for 5.4 shall be obtained from samples previously used for the tests outlined in section 5.1.

Two special samples of each rod size will be supplied by Ohio Brass Co. for the tests defined in section 5.3. These are referenced as 25k SML Special samples and 50k SML Special samples for the 5/8" and 7/8" rod diameter types, respectively.

3. DEFINITIONS

For the purposes of the specification, the following definitions shall apply.

3.1 Core - The core is the strength member of the polymer, composite insulator. It is composed of fiberglass rod.

3.2 Housing - The housing is the exterior insulating portion of the insulator which protects the core from the weather. It is composed of a polymer.

3.3 Metal Fitting - The metal fitting is the structural portion of the insulator intended to transfer load from the core to a support structure or to the apparatus to be supported.

3.4 Crimp Zone - That portion of the metal fitting which is used to

connect the metal fitting to the core.

3.5 Flashover - A disruptive discharge through the medium (normally air) from the energized portion of an insulating body to ground.

3.5 Coupling - That portion of the metal fitting which transmits the load from the insulator to devices external to the insulator.

4. CLASSIFICATION

The tests outlined in section 5 are classified as design tests. If necessary, additional detail can be found in section 5 of IEC 1109.

5. DESIGN TESTS (Boss)

Within sections 5.1, 5.2, 5.3 and 5.4, the tests shall be performed in sequence.

5.1 Tests on interfaces and connections of metal fittings

5.1.1 Test specimens and preliminary tests
Three samples each of 25k SML and 50k SML shall be tested in each of the following sections. Each sample shall be independently identified for reference throughout the test program.

5.1.2 Dry power frequency voltage test
The results of this test shall serve as a control. Each sample shall be subjected to 5 separate flashovers. The applied voltage shall be either nominal 50 or 60 Hz a.c. The flashovers shall be recorded as the r.m.s. value of the peak voltage. The voltage shall be increased linearly from zero to the flashover point within 1 minute.

The 5 flashovers shall be corrected to normal atmospheric conditions in accordance with IEC 60-1. The weather conditions and the appropriate correction factors shall be listed. Both the uncorrected and corrected data shall be recorded.

The average of the 5 corrected flashovers for each sample shall be calculated, and recorded.

5.1.3 Prestressing

Tests shall be performed in the following sequence.

5.1.3.1 Sudden load release test

With the temperature of each insulator between -20o C. and -25o C. (when measured at the smallest diameter surface of the housing), apply a tensile load between the coupling points of each of the samples in accordance with the table below. Then release the load rapidly (within less than 0.1 seconds), such that the final load is zero, within the precision of the measuring instrument.

Repeat the above procedure 5 times for each insulator.

Insulator Type	Load to be applied, (min.) lbs
25k SML Samples	7,500
50k SML Samples	15,000

5.1.3.2 Thermal-mechanical test

Make a permanent mark in the crimp zone at each end of each insulator. These should be aligned to allow a linear measurement of the distance between the opposing marks on any individual insulator. Apply a tensile load between the coupling points of each insulator in accordance with the table below. Measure the distance between the opposing marks on each individual insulator to a precision of ±0.020" (.5mm) and record the result.

Insulator Type	Load to be applied, (min.) lbs
25k SML Samples	1,250
50k SML Samples	2,500

This portion of the test may be performed in air or any other suitable medium. While at ambient temperature, load each insulator in tension between the coupling points to the appropriate load listed in the table below. Maintain that load during thermal cycling as depicted in Figure 1. The temperature extremes shall be +50°C ± 5°C and -35°C ± 5°C.

Insulator Type	Load to be applied, (min.) lbs
25k SML Samples	12,500
50k SML Samples	25,000

The thermal cycling may be interrupted for maintenance for a total duration of 4 hours without affecting the validity of the test.

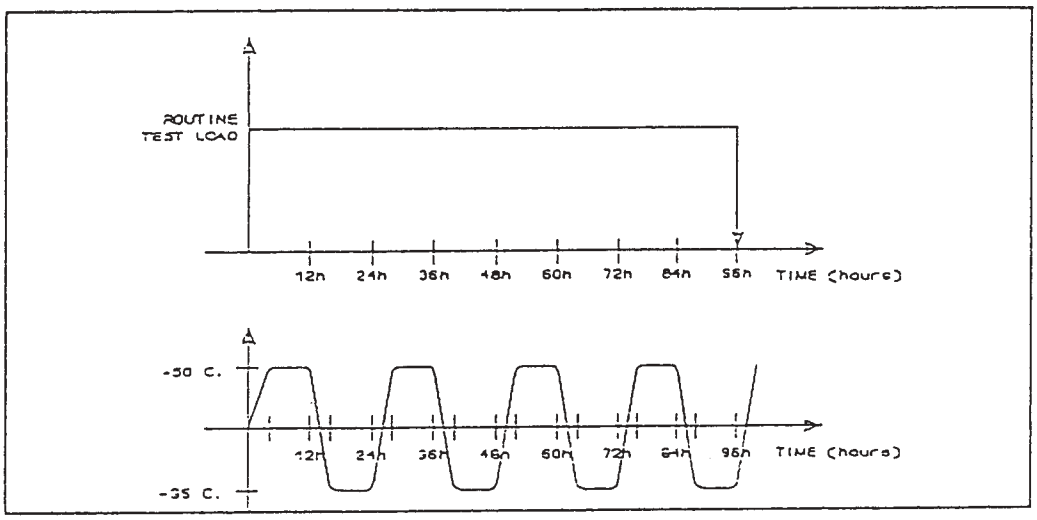


Figure 1

Following the conclusion of the thermal cycling, apply a tensile load between the coupling points of each insulator in accordance with the table below. Measure the distance between the opposing marks on each individual insulator to a precision of ±0.020" (.5mm) and record the result.

Insulator Type	Load to be applied, (min.) lbs
25k SML Samples	1,250
50k SML Samples	2,500

5.1.3.3 Water immersion test

This test shall be performed in a boiling solution of deionized water with 0.1% (by weight) of NaCl. Each insulator shall be immersed in the boiling solution for a minimum of 42 continuous hours.

When the boiling portion of the test is complete, the temperature of the solution shall be reduced to 50°C. and maintained until the test described in section 5.1.4 can be initiated.

5.1.4 Verification Tests

Tests 5.1.4.1, 5.1.4.2 and 5.1.4.3 shall be completed within 48 hours of the completion of section 5.1.3.3.

5.1.4.1 Visual examination

Each insulator's housing shall be inspected visually. No cracks, other than those which are a normal part of the assembly, are permitted.

5.1.4.2 Steep-front impulse voltage test

An electrode consisting of a clip made of a copper strip approximately 20 mm wide and less than 1 mm thick shall be banded around each test specimen, subdividing the insulator into two approximately equal test sections.

An impulse voltage with a front steepness of at least 1000 kV/microsecond shall be applied to each test section. Each test section shall be stressed with 25 impulses of positive and 25 impulses of negative polarity. Each impulse shall cause an external flashover of the test section. No puncture shall occur. Following the test, the electrode used to form the test sections shall be removed.

5.1.4.3 Dry power frequency voltage test

5.1.4.3.1 Each sample shall be subjected to 5 separate flashovers. The applied voltage shall be either nominal 50 or 60 Hz a.c. The flashovers shall be recorded as the r.m.s. value of the peak voltage. The voltage shall be increased linearly from zero to the flashover point within 1 minute.

The 5 flashovers shall be corrected to normal atmospheric conditions in accordance with IEC 60-1. The weather conditions and the appropriate correction factors shall be listed. Both the uncorrected and corrected data shall be recorded.

The average of the 5 corrected flashovers for each sample shall be calculated, and recorded. The average value of the flashover voltages shall not be smaller than 90% of the values determined in section 5.1.2 for each specimen.

5.1.4.3.2 Immediately before initiating section 5.1.4.3.3, measure the temperature of the insulator at the surface of the smallest cross sectional area of the housing and record that value.

5.1.4.3.3 Each test specimen shall be individually subjected for 30 minutes to 80% of the average flashover voltage measured for that specimen in section 5.1.2. No puncture shall occur.

5.1.4.3.4 Immediately after removal of the voltage, measure the temperature of the insulator at the location utilized for 5.1.4.3.2. Record the value. The temperature difference between the final measurement and that taken in 5.1.4.3.2 shall not represent an increase of more than 20°C.

5.2 Assembled core load-time test

5.2.1 Test specimens

Six insulators from the 25k SML samples and six from the 50k SML samples shall be tested.

5.2.2 Mechanical load test

This test will be performed at ambient temperature.

5.2.2.1 Determination of the average failing load of the core of the assembled insulator.

Three of each type of insulator shall be loaded in tension between the coupling points. The tensile load shall be increased rapidly, but smoothly, from zero to approximately 75% of the expected mechanical failing load (listed as loading point 1 in the table below). At this point a clock shall be started. The load shall be gradually increased in a time between 30 and 40 seconds to loading point 2. The loading rate shall be maintained to reach loading point 3 in a time between 80 and 90 seconds unless breakage of the core or complete pull out occurs. The maximum tensile load achieved during the test shall be recorded. Any test leading to a failure of the couplings shall be ignored and an additional sample shall be tested to replace that unit.

The average of the three qualifying failing loads shall be calculated. That average will be designated the Average Failing Load for that class of insulator.

	¦---------- lbs ----------¦		
	Loading Point	Loading Point	Loading Point
Insulator Type	1	2	3
25k SML Samples	18,750	25,000	37,500
50k SML Samples	37,500	50,000	75,000

5.2.2.2 Control of the slope of the strength-time curve of the insulator

The remaining three insulators of each type shall be subjected to a tensile load equivalent to 60% of the respective Average Failing Load (calculated in 5.2.2.1). The load shall be applied smoothly and then maintained for 96 hours without failure (breakage or complete pull out).

5.3 Test of housing: tracking and erosion test

5.3.1 Test specimens

Two 25k SML Special samples and Two 50k SML Special samples shall be tested.

5.3.2 Test Procedure

The test is a time-limited continuous test under salt fog at constant power frequency voltage in the range of 14 kV to 20 kV. The test is performed in a moisture sealed corrosion-proof chamber, the volume of which shall not exceed 10 m^3. An aperture of not more than 80 cm^2 shall be provided for the natural exhaust air. A turbo sprayer or room humidifier of constant spraying capacity shall be used as a water atomizer.

For power frequency test voltage, a test-transformer shall be used. The test circuit, when loaded with a resistive current of 250 mA (r.m.s.) on the high voltage side, shall experience a maximum voltage drop of 5%.

The protection level shall be set at 1 A (r.m.s.).

The test specimens shall be cleaned with deionized water before starting the test. One test specimen of each type shall be mounted horizontally (at approximately half the height of the chamber) and the second mounted vertically. There shall be a clearance of at least 200 mm between the roof of the chamber and test specimens and a clearance of 100 mm from the walls. The test voltage (in kilovolts) is determined by dividing the creepage distance in millimeters by 34.6.

The fog will fill up the chamber and not be directly sprayed onto the test specimen. A solution prepared with NaCl and deionized water will be supplied to the sprayer. The solution may not be recirculated.

5.3.3 Test Conditions

Duration of the test	1000 hours
Water flow rate	(0.4 $\pm$ 0.1) l/m^3/hour
Size of droplets	5 um to 10 um
Temperature	20°C $\pm$ 5 K
NaCl content of water	(10 $\pm$ 0.5) kg/m^3

5.3.4 Evaluation of the test

Each overcurrent trip-out shall be reported with details of the sample on which it occurred as well as the approximate

time at which it occurred (+/- 10 hours).

At the conclusion of the test, each sample shall be visually examined. Identifiable tracking of the sheath, erosion exposing the core, punctures of weathersheds, or other exposure of the core shall be noted.

5.4 Tests for the core material

5.4.1 Dye penetration test

5.4.1.1 Test specimens

Ten core samples, 10 mm ± 0.5 mm long, shall be cut from one insulator of the 25k SML samples and of the 50k SML samples (see section 2). The cuts shall be made at approximately 90° to the axis of the core with a diamond-coated circular saw blade, cooled with water. The cut surfaces of the rod may be smoothed with fine abrasive cloth (180 grit). The cut ends shall be clean.

5.4.1.2 Performance of the test

A layer of steel or glass balls of similar diameter (1 to 2 mm) shall be placed in a glass vessel. A 1% alcohol solution (1 g fuchsin in 100 g ethanol) shall be poured into the vessel to a level 2 to 3 mm above the level of the balls.

Each of the specimens shall be placed (fibers vertical) on the balls, submerging one end face in the dye solution.

The time for the dye to rise through the specimens to the upper end face by capillarity shall be measured.

5.4.1.3 Acceptance criterion

At the end of 15 minutes, no dye shall have risen through the specimens by capillarity.

5.4.2 Water diffusion test

5.4.2.1 Test specimens

Six core samples, 30 mm ± 0.5 mm long, shall be cut from one insulator each of the 25k SML samples and of the 50k SML samples (see section 2). The cuts shall be made at approximately 90° to the axis of the core with a diamond-coated circular saw blade, cooled with water. The cut surfaces of the rod may be smoothed with fine abrasive cloth (180 grit). The cut ends shall be clean.

5.4.2.2 Prestressing

The surfaces of the specimens shall be cleaned with isopropyl alcohol and filter paper. The specimens will be boiled in deionized water with 0.1% NaCl by weight. Boiling will continue for 100 hours ± 0.5 hours.

After boiling, the samples shall be placed in another glass

container filled with tap water at ambient temperature for a minimum of 15 minutes. The voltage test (5.4.2.3) shall be performed within 3 hours of the removal of the specimens from the boiling container.

5.4.2.3 Voltage test

The voltage test shall be carried out with the apparatus shown in figure 2.

Immediately before the voltage test the specimens shall be removed from the glass container and their surfaces dried with filter paper.

Each specimen shall then be put between the electrodes. The test voltage will be increased at approximately 1 kV/second up to 12 kV. Maintain the voltage at 12 kV for 1 minute, then decrease it to zero.

No surface flashover or puncture shall occur, and the current shall not exceed 1 mA (r.m.s.).

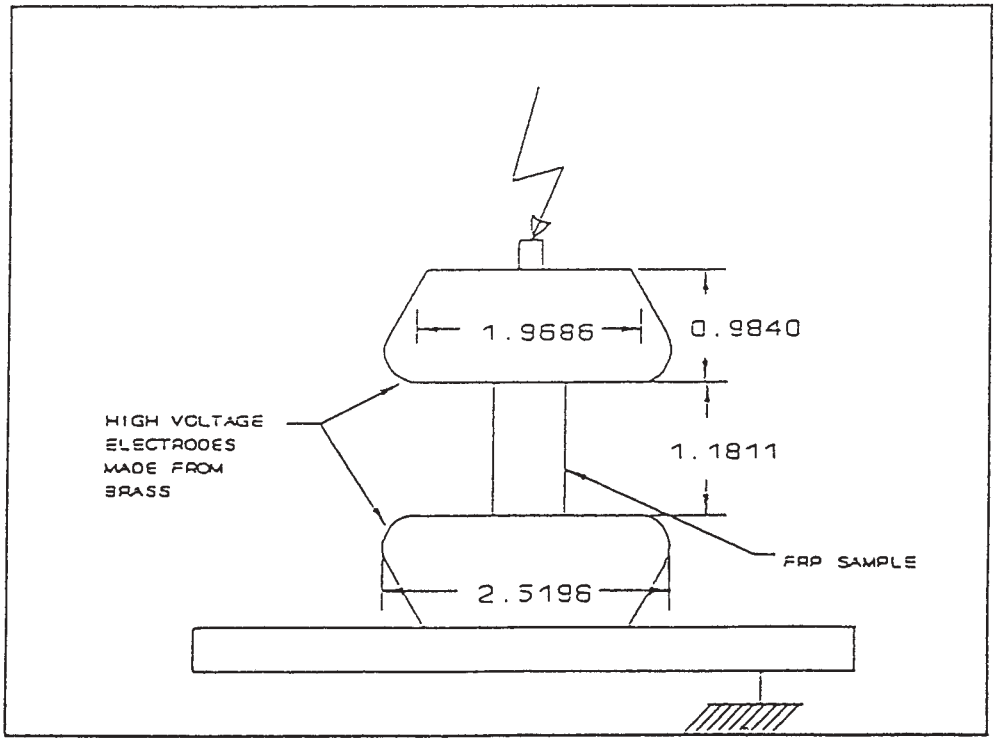


Figure 2

6. TEST REPORT

A confidential test report shall be prepared regarding only the test procedures listed in section 5. The report shall be subdivided according to the appropriate section numbers (i.e. 5.1, 5.2, 5.3 and 5.4) and titles. These section numbers and titles match those in IEC 1109 (1992 edition). The test descriptions are paraphrased from those contained within the IEC standard.

Equipment used and detailed results (including graphs and photographs) shall be included either in the main body of the report or as an appendix. Uncorrected and preliminary data shall be contained in an appendix to the report.

The report shall be titled as noted below:

DESIGN TEST REPORT
IEC 1109
OHIO BRASS HI*LITE XL

Upon successful completion, a conclusion confirming that the Ohio Brass Hi*Lite design meets all "Design Test" requirements of IEC 1109 shall be appended to the report.

Three copies of the report will be delivered to Ohio Brass.

Annex C
IEC 1109

client	HUBBELL - The Ohio Brass Co., Wadsworth (USA)
equipment under test	n°1 composite insulators with 120 kN SML n°1 composite insulators with 210 kN SML
tests performed	Tracking and erosion test of housing in severe environmental conditions
normative documents	IEC 1109, - Annex C (1992) - and Client's requests
test date	1 september 1996 - 10 april 1997

no. of pages	20
issue date	31 July 1997
prepared	TEST - A. Sironi TEST - I. Aliprandi
approved	TEST - U. Colombo

CESI
CENTRO ELETTROTECNICO SPERIMENTALE ITALIANO
Il Direttore Area Laboratori

tests witnessed by:

identification of the object:

The Manufacturer guarantees that the tested object is manufactured according to the submitted drawings. CESI checked that these drawings adequately represent in shape and dimensions the essential details and parts of the tested object. These drawings identified by CESI and numbered 97/015392 no.2 and 97/015390 n.2 are annexed to this report.

the data necessary to permit repetition of the tests are contained in the document marked: \

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laboratory informations

CESI testing team: Sig. Aliprandi Ilario
Sig. Aprile Giuseppe

annex: calibration of the measurement system and scale, pag.

test laboratory: P231 Servathin

keywords:12015R 22342W 31020W 44040V 53001D 62570N

1. TEST OBJECT CHARACTERISTICS

1.1 N° 1 composite insulator - 5/8 HI lite XL suspension - with 120 kN SML. The subject insulator has been mounted vertically in the testing room. The main insulator characteristics are:

- manufacturer:	The Ohio Brass Co. (USA)
- type:	n° 234063-3001 Prototype
- creepage distance:	545 mm
- arcing distance:	215 mm
- specified mechanical load (SML):	120 kN
- drawing no.	S006156-00 Rev. no. 2
- year of construction:	1996
- weathershed material:	ESP™

A view of the insulator before the test is shown in the figure in page 5.

1.2 N° 1 composite insulator - HI lite suspension insul - with 210 kN SML. The subject insulator has been mounted horizontally in the testing room. The main insulator characteristics are:

- manufacturer:	The Ohio Brass Co. (USA)
- type:	n° 234068-3001 Prototype
- creepage distance:	535 mm
- arcing distance:	210 mm
- specified mechanical load (SML):	210 kN
- drawing no.	S006215-00 Rev. no. 2
- year of construction:	1996
- weathershed material:	ESP™

A view of the insulator before the test is shown in the figure in page 6.

Fig. 1 - View of the insulator n° 234063-3001 before the test

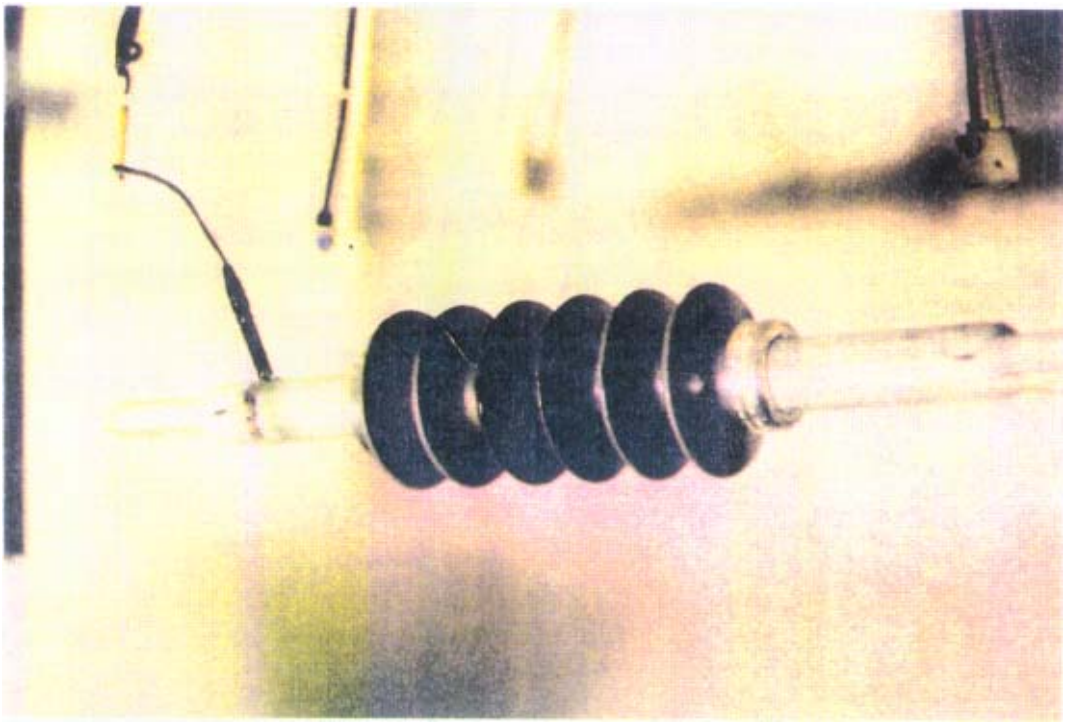


Fig. 1 - View of the insulator n° 234063-3001 before the test

2. VERIFICATION OF THE TEST OBJECT DIMENSIONAL CHARACTERISTICS

The test object dimensional characteristics measured on the insulators are reported in the following table:

sample	number of sheds	height [mm]	shed diameter [mm]	creepage distance [mm]	core diameter [mm]	spacing [mm]
n° 234063-3001	6	540	92	550	25	36
n° 234068-3001	6	650	100	550	32	37

note:

The checked dimensions have been found in satisfactory agreement with those submitted by the Client.

3. TEST CARRIED OUT

Ageing test under operating voltage simulating weather conditions:

Test voltage: Vt = 15.8 kV
Test duration: 5000 h.

4. REFERENCE STANDARD

The test procedure has been according to IEC Publication 1109 - Annex C - (1992), following:
- On Client request prototype n°234063-3001 has been tested only in vertical position.
- On Client request prototype n°234068-3001 has been tested only in horizontal position.

5. TEST PROCEDURE

The test procedure is based on the repetition of a daily cycle for 208 times for a total duration of about 5000 hours.
A scheme of the daily ageing cycle is shown in fig. 3 on page 9.
A sketch of the test configuration is shown in figure 4 on page 10.
During the test the samples have been energized at a power frequency voltage equal to Vt = 15.8 kV.
The main characteristics of the different environmental stresses applied during the test are reported in the following table:

environmental stress	daily duration [h]	total duration [h]	severity
salt fog	8	1664	7 g/l - 0.4 l/h per m^3
humidification	4	832	98 %
rain	2	416	100 Ωm - 1.5 mm/min
U.V. radiation	12	2496	90 mW/cm^2
heating	10	2080	50 °C

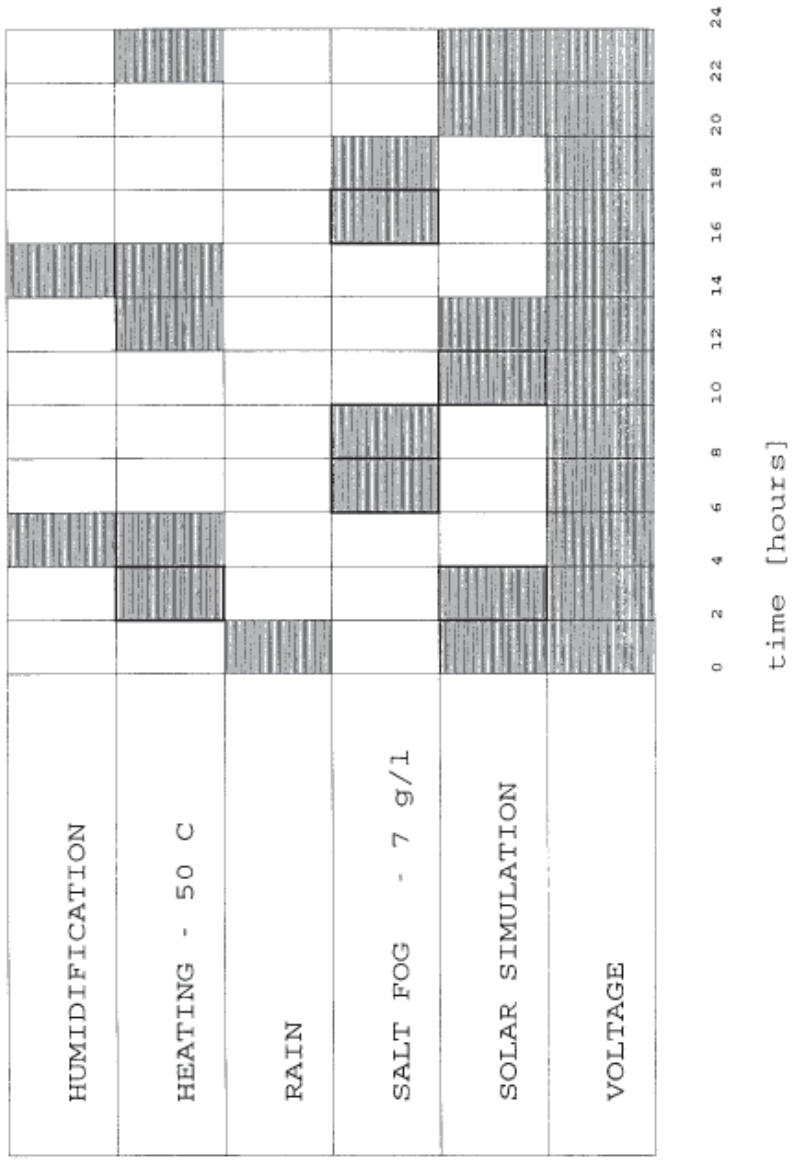


Fig. 3 - Scheme of the daily aging cycle

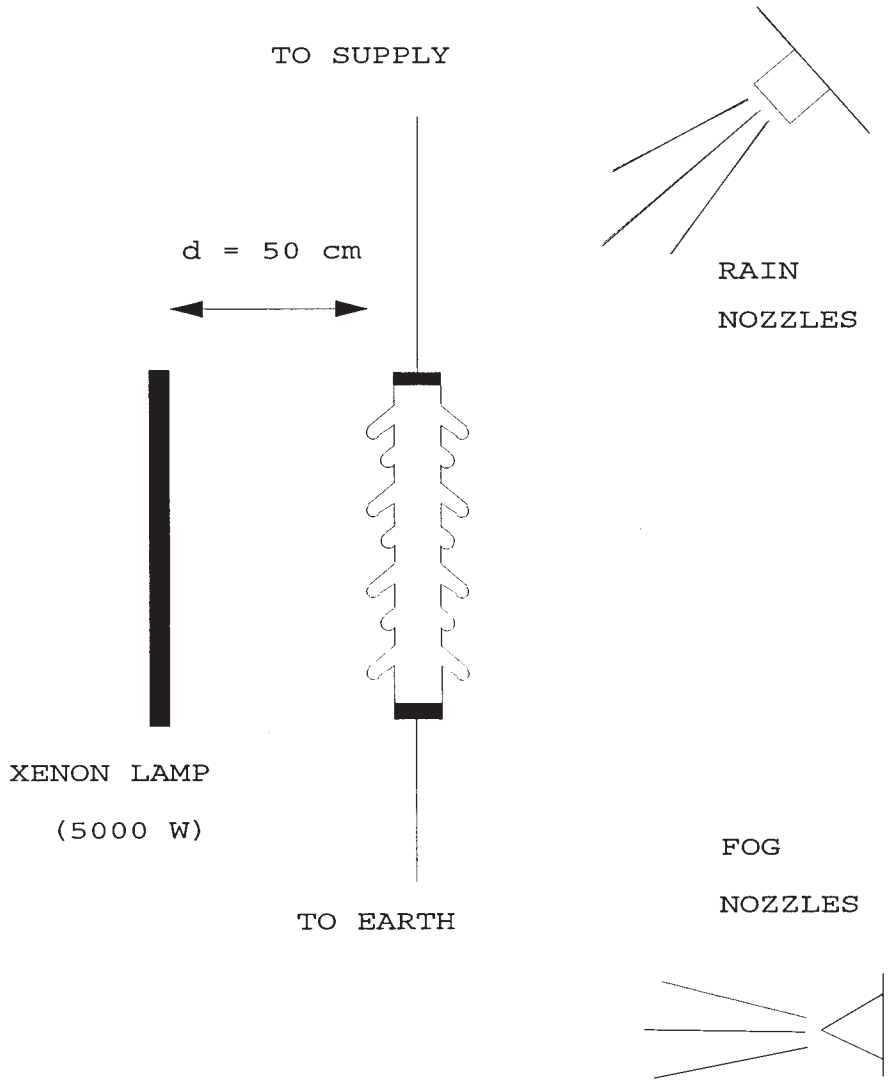


Fig. 4 - Sketch of the test configuration

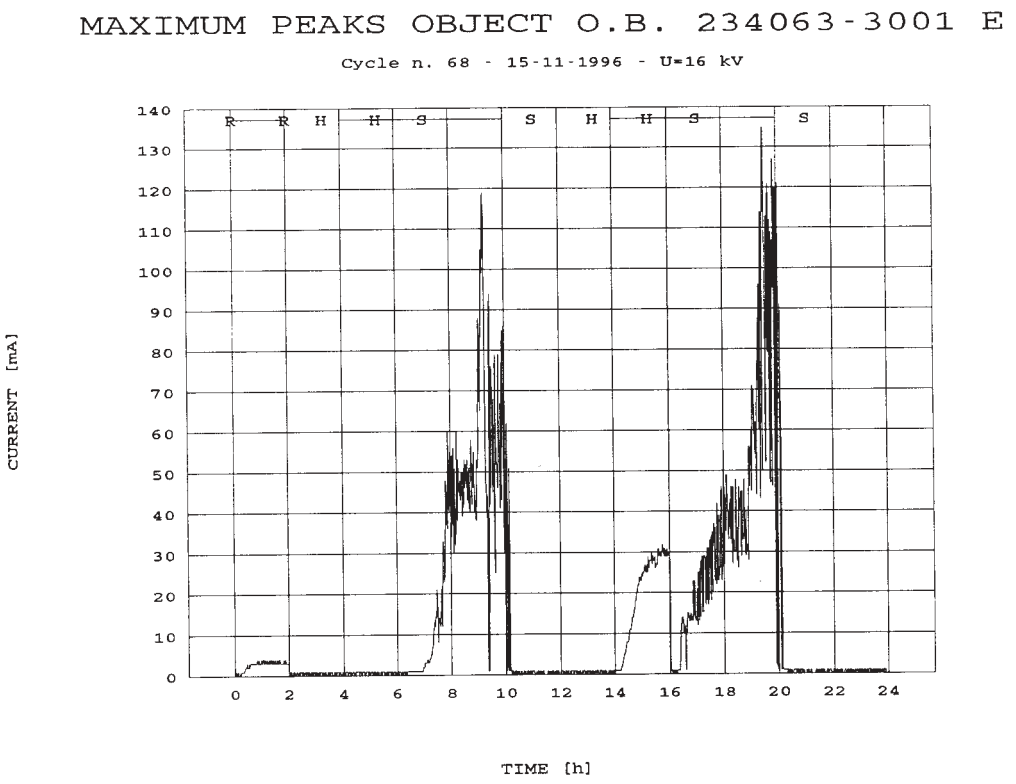
6. TEST RESULTS

6.1 External leakage current flowing during the test

No flashover has been observed during the test on the sample.
The value of the maximum peak current measured during the whole test is given in the below table.

test sample	maximum peak current [mA]
n° 234063-3001	135
n° 234068-3001	118

An example of the trend of the peak current and cumulated energy relevant to each insulator during a daily cycle is given in the figures from page 12 to page 13. The examples refer to the cycles where maximum peak occurred.



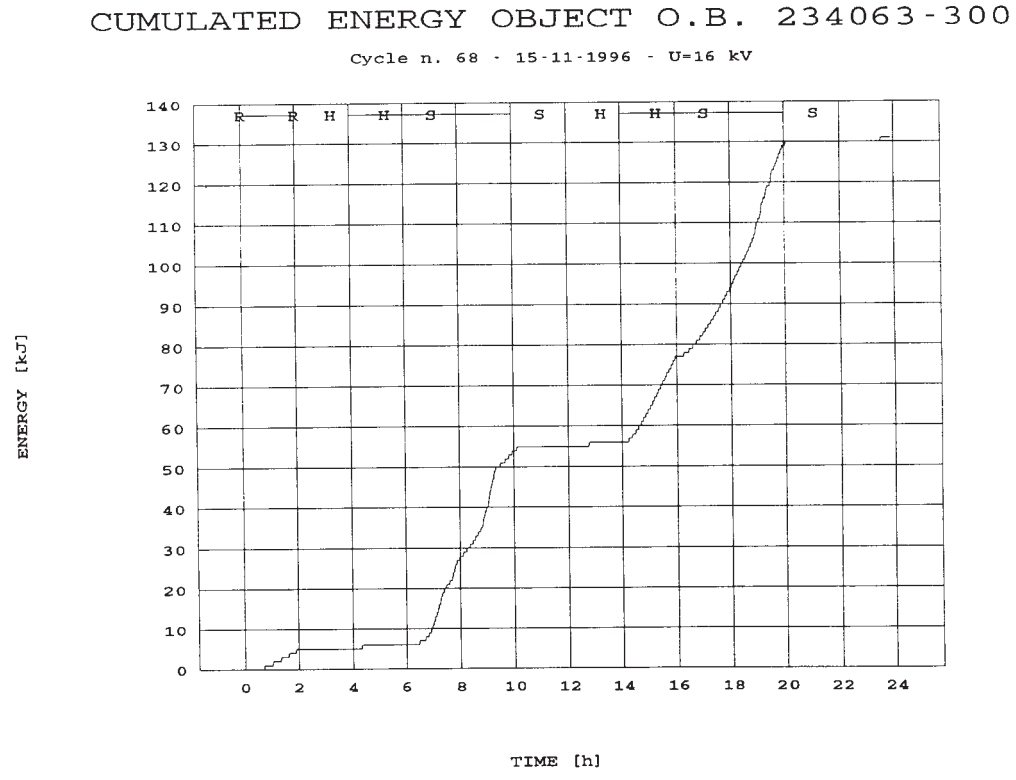
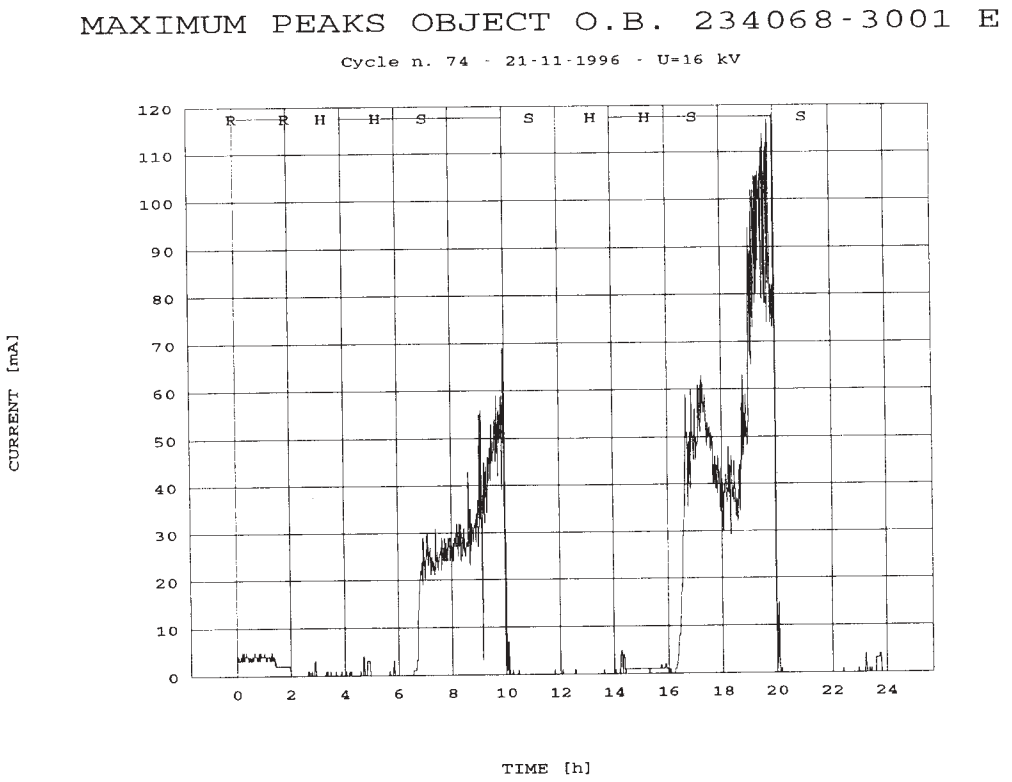


Fig 5 - Example of the trend of the peak current and of the cumulated energy during a daily cycle.



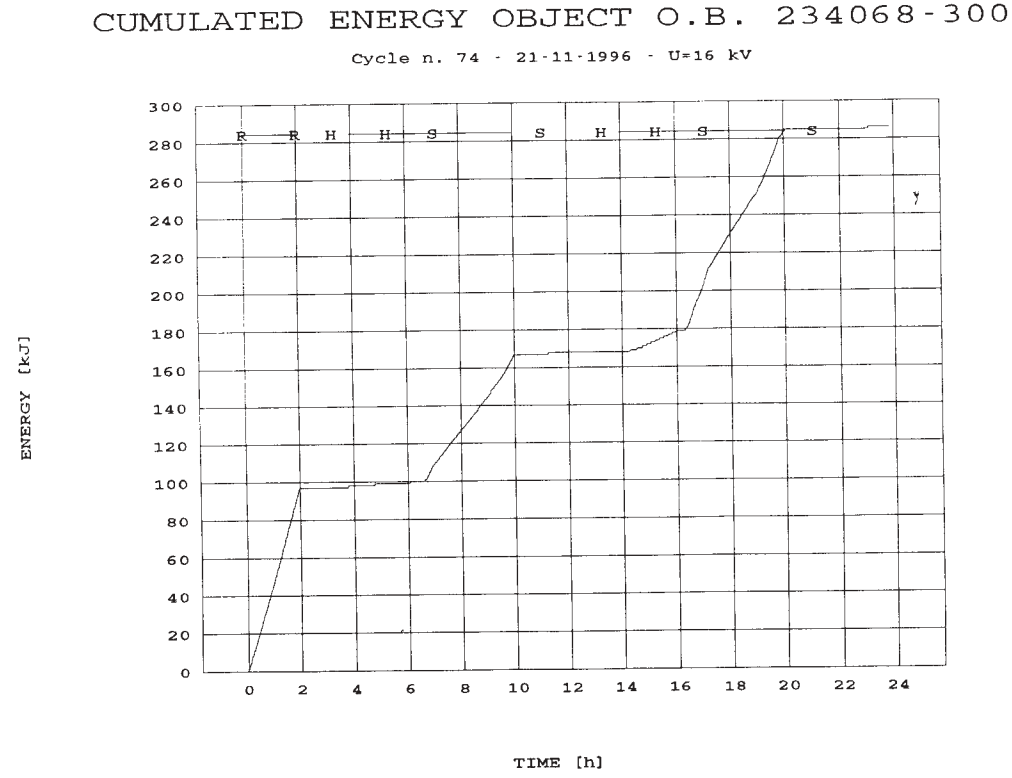


Fig 6 - Example of the trend of the peak current and of the cumulated energy during a daily cycle.

6.2 Surface conditions after the test

Ohio Brass n° 234063-3001:

No significant tracking and shed punctures have been observed on the tested sample.
Light erosion has been observed in correspondence to the moulding line.
Salt deposits are visible on the core and under the sheds.

A view of the insulators and details of the surface at the end of the test are shown in the figs. 7 and 8 on pages 16 and 17, respectively.

Ohio Brass n° 234068-3001:

No significant tracking and shed punctures have been observed on the tested sample.
Light erosion has been observed on the core between third and fourth shed (fig. 10 on page 19), and in correspondence to the moulding line.
Salt deposits are visible on the core and under the sheds.

A view of the insulators and details of the surface at the end of the test are shown in the figs. 9, 10 and 11 on pages 18, 19 and 20, respectively.

7. Conclusions

Flashover has not occurred during the whole test period of 5000 hours on the tested samples.
Very light erosion has been observed on the surface of the tested sample n° 234068-3001 and 234063-3001 at the end of the test.

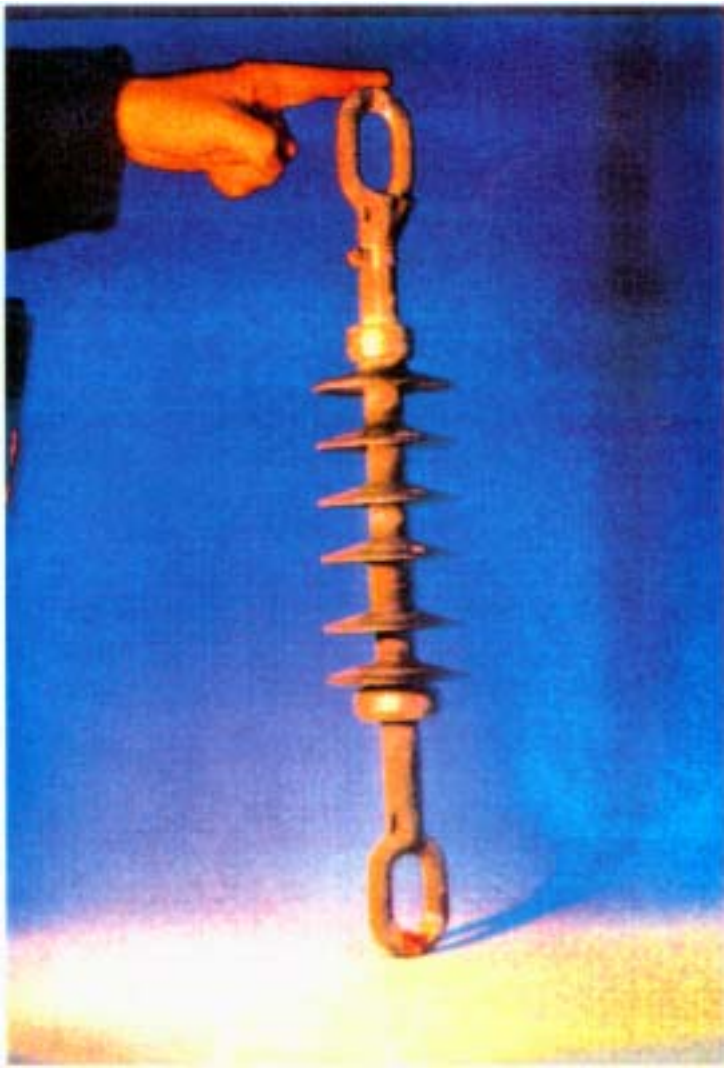


Fig. 7 - View of the insulator n° 234063-3001 after the test

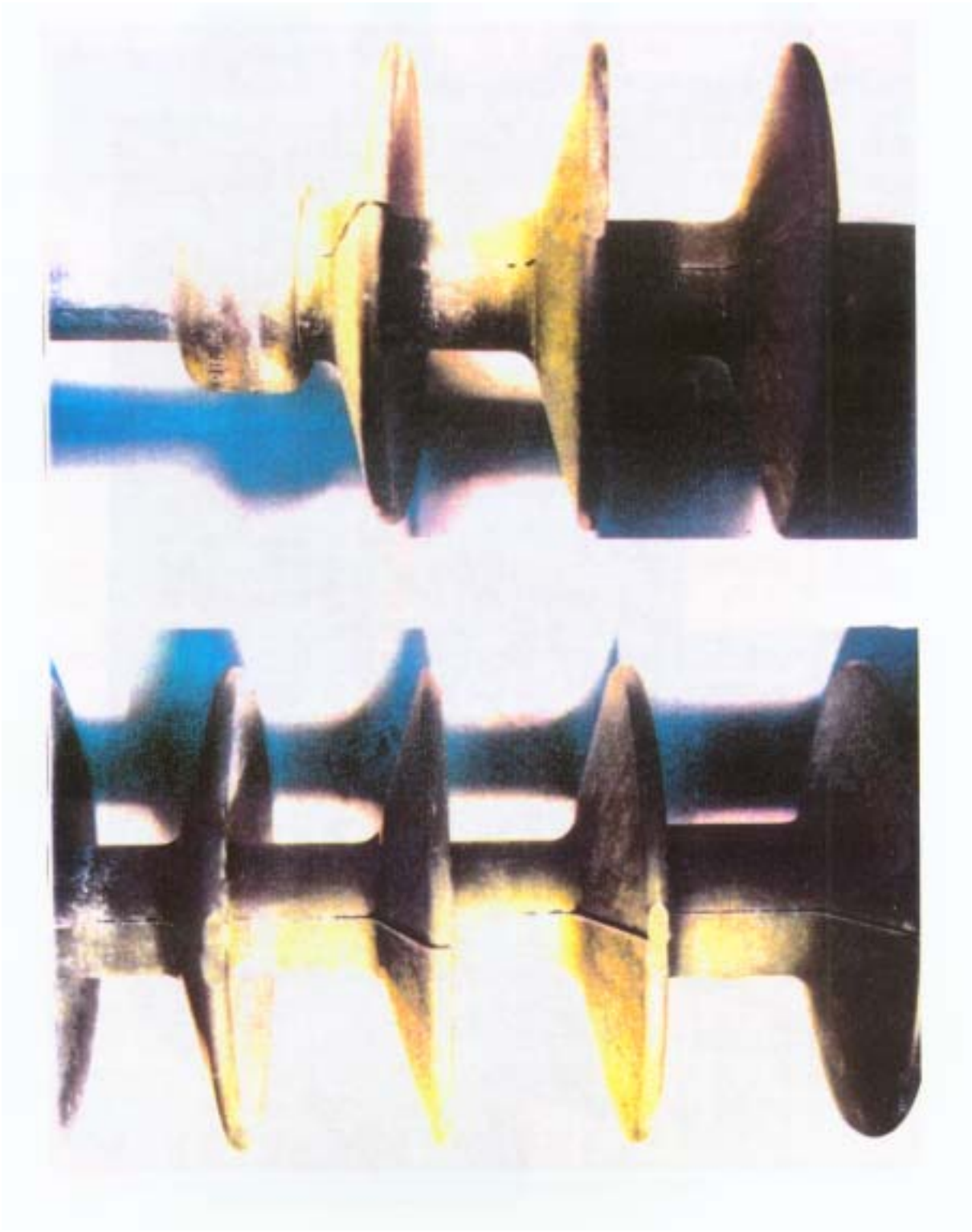


Fig. 8 - Details of the insulator n° 234063-3001 after the test

Fig. 9 - View of the insulator n° 234068-3001 after the test

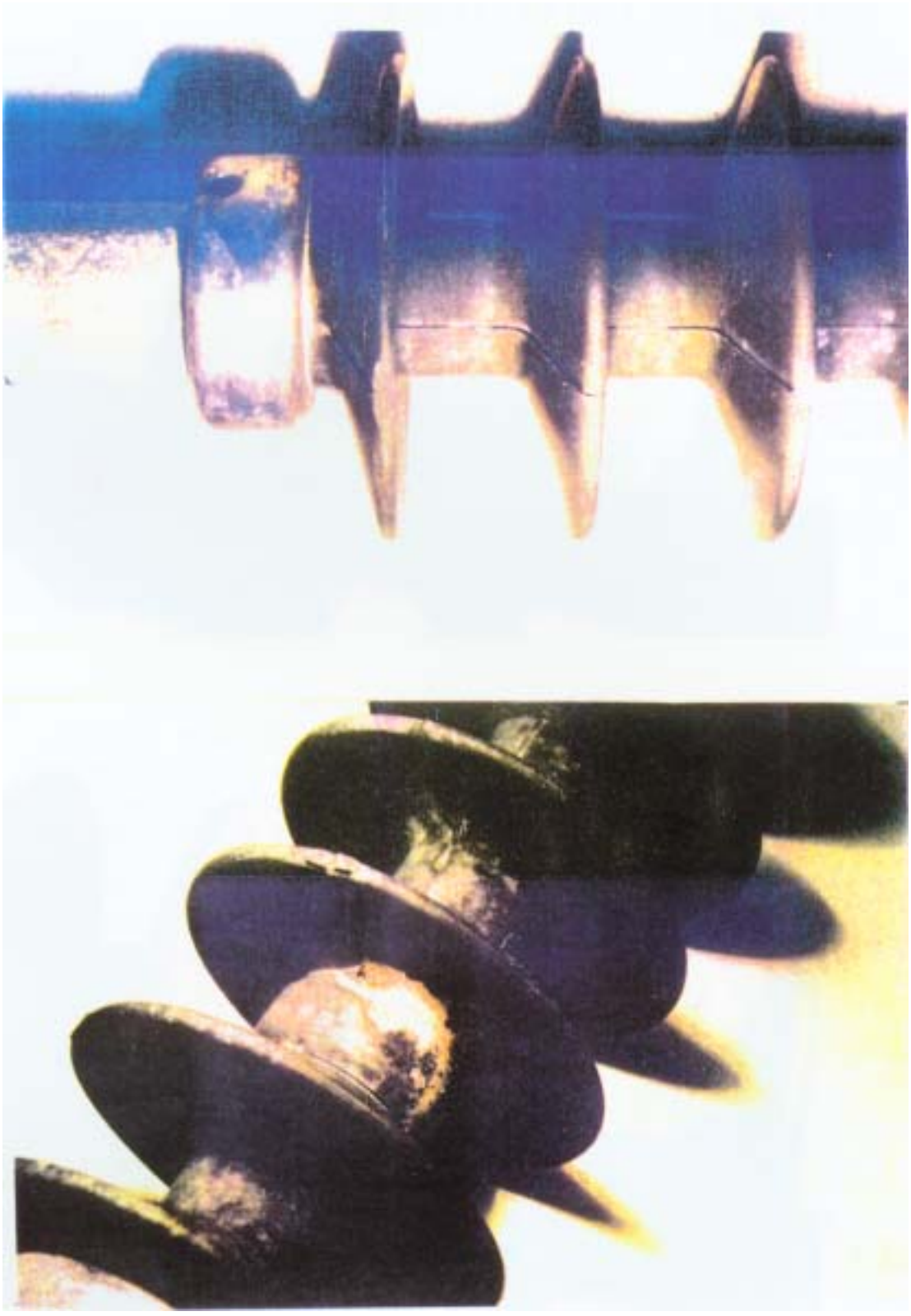


Fig. 10 - Details of the insulator n° 234068-3001 after the test

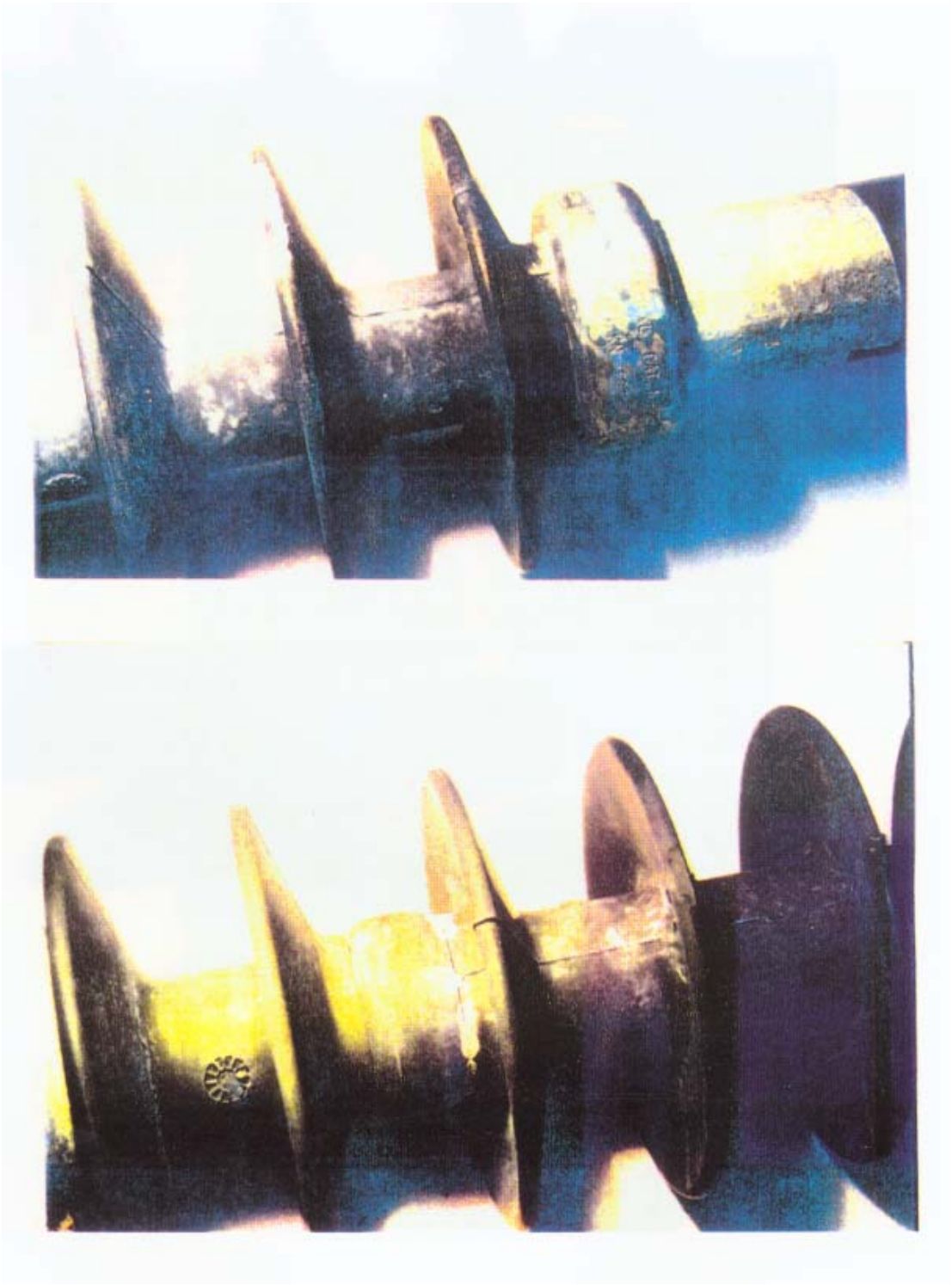


Fig. 11 - Details of the insulator n° 234068-3001 after the test

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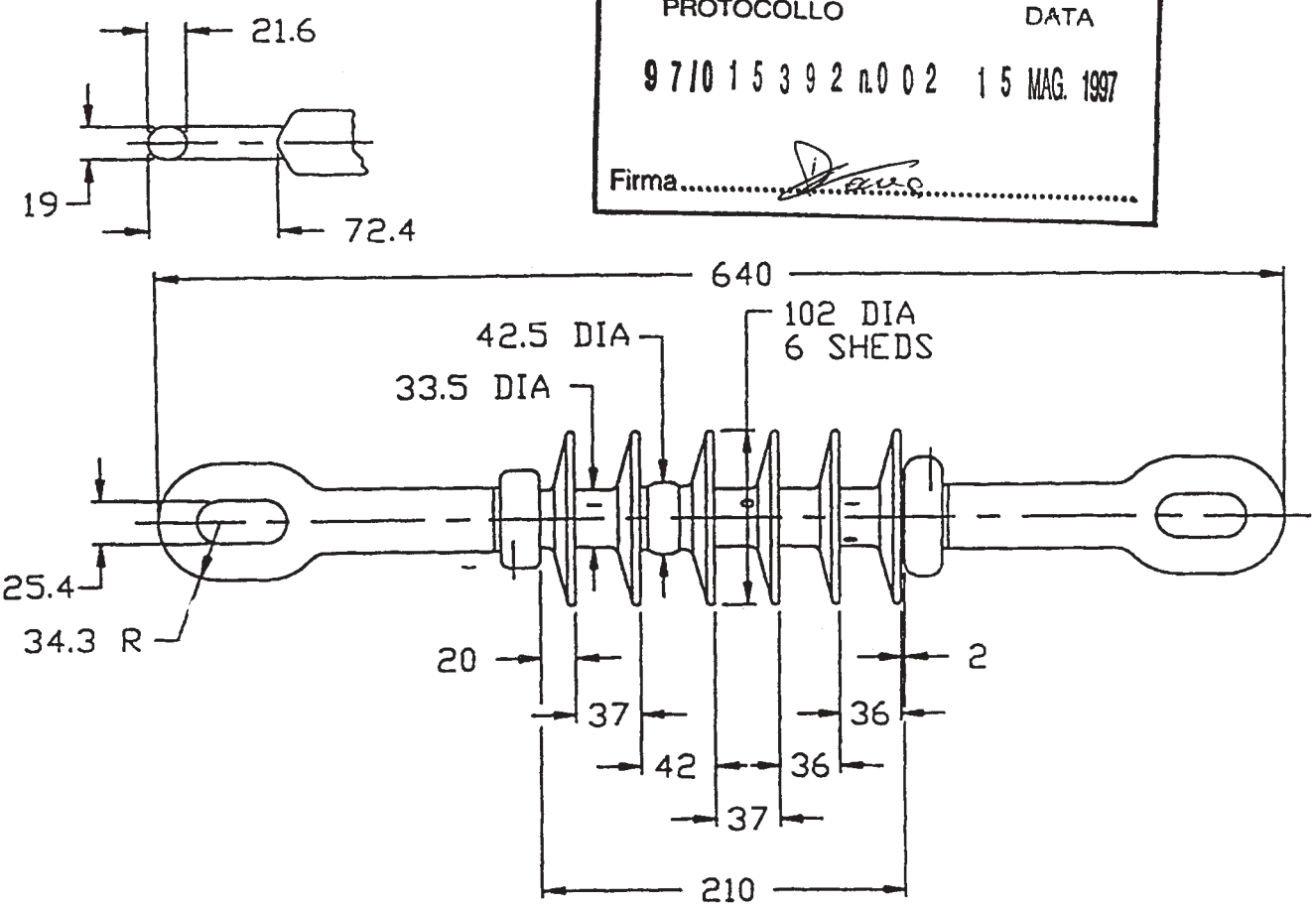


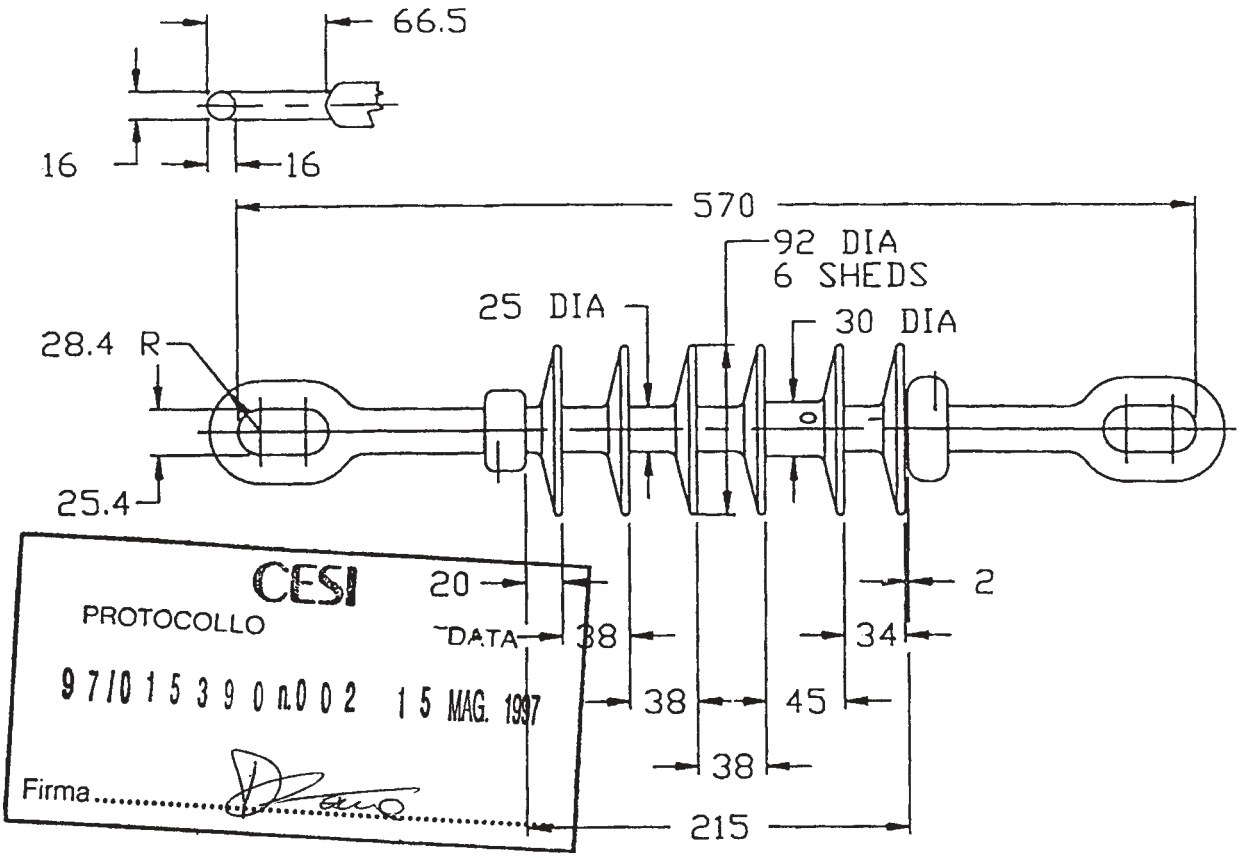
METRIC DIMENSIONS UNLESS OTHERWISE NOTED

STRIKE DISTANCE	215mm
LEAKAGE DISTANCE	535mm
DRY 60 HZ FLASHOVER	80 KV
WET 60 HZ FLASHOVER	80 KV
IMPULSE CRITICAL POSITIVE	155 KV
IMPULSE WITHSTAND POSITIVE	145 KV
IMPULSE CRITICAL NEGATIVE	125 KV
IMPULSE WITHSTAND NEGATIVE	120 KV
SPECIFIED MECHANICAL LOAD	210 kN
ROUTINE TEST LOAD	105 kN
WEIGHT	3.2 kg

HUBBELL/THE OHIO BRASS CO.

8711 WADSWORTH ROAD, WADSWORTH, OHIO

PART HI LITE SUSPENSION INSUL			SCALE .25=1
NAME 234068-3001 PROTOTYPE			
DESIGN RAB	DATE 09/24/93	DWG. NO. S006215-00	REV. NO. 02
DRAWN JVR	DATE 11/29/93		



METRIC DIMENSIONS UNLESS OTHERWISE NOTED.

STRIKE DISTANCE	215 mm
LEAKAGE DISTANCE	545 mm
DRY 60 HZ FLASHOVER	80 KV
WET 60 HZ FLASHOVER	80 KV
IMPULSE CRITICAL POSITIVE	160 KV
IMPULSE WITHSTAND POSITIVE	150 KV
IMPULSE CRITICAL NEGATIVE	130 KV
IMPULSE WITHSTAND NEGATIVE	120 KV
SPECIFIED MECHANICAL LOAD	120 kN
ROUTINE TEST LOAD	60 kN
WEIGHT	1.4 kg

HUBBELL/THE OHIO BRASS CO.

8711 WADSWORTH ROAD, WADSWORTH, OHIO

PART 5/8 HI LITE XL SUSPENSION			SCALE .25=1
NAME 234063-3001 PROTOTYPE			
DESIGN RAB	DATE 09/20/93	DWG. NO. S006156-00	REV. NO. 02
DRAWN JVR	DATE 11/29/93		