

KEMA TYPE TEST CERTIFICATE OF DIELECTRIC PERFORMANCE

Object A three-pole solid-dielectric pole-mounted vacuum automatic circuit-recloser **1144-16**

Type OSM 38-16-800 **Serial No.** 0800316021969

Rated voltage 38 kV Rated frequency 50/60 Hz
Rated current 800 A

Manufacturer NOJA Power Switchgear Pty. Ltd.,
Brisbane, Australia^{*)}

Client NOJA Power Switchgear Pty. Ltd.,
Brisbane, Australia

Tested by KEMA Nederland B.V.,
Arnhem, The Netherlands

Date of tests 7 to 8 April 2016

The object, constructed in accordance with the description, drawings and photographs incorporated in this Certificate, has been subjected to the series of proving tests in accordance with

IEC 62271-111 (2012) subclauses 6.2.
IEEE C37.60 (2012)

The results are shown in the record of proving tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above standard(s) and to justify the ratings assigned by the manufacturer as listed on page 4.

This Certificate 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 Certificate consists of 19 pages in total.



Laboratories

Arnhem, 29 April 2016

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 object tested has fulfilled the requirements of this standard and the relevant ratings assigned by the manufacturer are endorsed by DNV GL. In addition, the object's technical drawings have been verified and the condition of the object after the tests is assessed and recorded. The Certificate contains the essential drawings and a description of the object 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 object 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 object's technical drawings have been verified and the condition of the object after the tests is assessed and recorded. The report is applicable to the object 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 sheet 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 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 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 OBJECT TESTED

1.1 Ratings/characteristics of the object tested

| | | |
|---|--------------------------|---|
| Frequency | 50/60 Hz | X |
| Maximum voltage | 38 kV | X |
| Power-frequency withstand voltage (1 min dry) | 70 kV | X |
| Power-frequency withstand voltage (10 s wet) | 60 kV | X |
| Lightning impulse withstand voltage | 170 kV | X |
| Continuous (normal) current | 800 A | |
| Short-time withstand current | 16 kA | |
| Peak withstand current | 41,6 kA _{peak} | |
| Duration of short-circuit | 3 s | |
| Symmetrical interrupting current | 16 kA | |
| Symmetrical (fault) making current | 41,6 kA _{peak} | |
| Operating sequence | O-0,1 s-CO-1 s-CO-1 s-CO | |
| Cable-charging interrupting current | 40 A | |
| Line-charging interrupting current | 5 A | |
| Supply voltage controller cubicle | 230 V a.c. | |

X = This rating has been proved by the tests of this Certificate.

1.2 Description of the object tested

Automatic circuit-recloser

| | |
|---------------------|---|
| Manufacturer | NOJA Power Switchgear Pty. Ltd., Brisbane, Australia |
| Type | OSM 38-16-800 |
| Serial number | 0800316021969 |
| Year of manufacture | 2016 |

Vacuum interrupters

| | |
|------------------------------|--------------------------------|
| Manufacturer | Siemens AG, Berlin, Germany |
| Type | VSR-38-0-16 |
| Serial number | 0800316021969 |
| Phase A | 329000864 |
| Phase B | 329000870 |
| Phase C | 329000869 |
| Rated voltage | 38 kV |
| Rated current | 800 A |
| Frequency | 50/60 Hz |
| Short-time withstand current | 16 kA |
| Duration of short-circuit | 3 s |

Recloser controller cubicle

| | |
|---------------|--|
| Manufacturer | NOJA Power Switchgear Pty Ltd., Brisbane, Australia |
| Type | RC-10 |
| Serial number | 0100116020878 |

Protection relay

| | |
|---------------|--|
| Manufacturer | NOJA Power Switchgear Pty Ltd., Brisbane, Australia |
| Serial number | 0311815100427 |

1.3 List of drawings

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 Certificate:

| Drawing no./document no. | Revision |
|--------------------------|----------|
| 300-3104, Page 1 | 0 |
| 300-3104, Page 2 | 0 |
| NOJA-464-32 | 5 |

The following drawings and/or documents have been stamped by KEMA Laboratories and returned to the manufacturer:

| Drawing no./document no. | Revision |
|--------------------------|----------|
| 300-3105 | 0 |
| 300-3106 | 0 |
| 115_56063_763 | 0C |
| 4D 115_56063_700 | 0A |
| 300-1323 | 0 |
| 300-1072 | F |
| 300-1298 | 0 |
| 300-1299 | 0 |
| 300-3024 | 1 |
| 310-1147 | 0 |
| 300-3031 | 2 |
| 300-1096 | 5 |
| 300-1101 | 1 |
| 300-1086 | 4 |
| 300-1154 | 3 |
| 300-1117 | 6 |
| 300-1037 | D |
| NOJA-461-30 | 4 |

2 GENERAL INFORMATION

2.1 The tests were witnessed by

Name

Griffiths, S.
Samarski, O.

Company

NOJA Power Switchgear Pty Ltd.,
Brisbane, Australia

2.2 The tests were carried out by

Name

Smeenk, S.

Company

KEMA Nederland B.V.,
Arnhem, The Netherlands

2.3 Purpose of test

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

2.4 Measurement uncertainty

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

3 DIELECTRIC TESTS

3.1 Test conditions

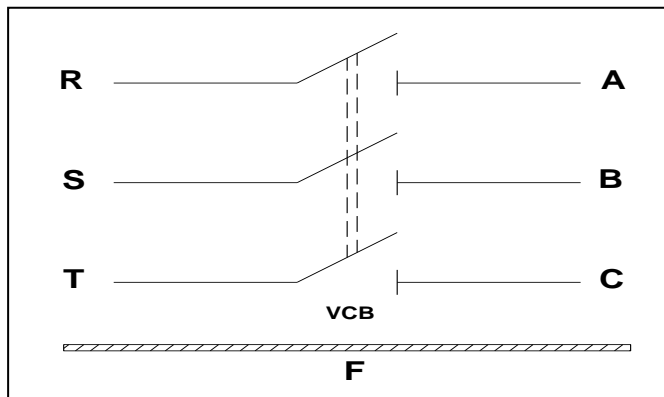


Figure 1 Main circuit of recloser

| Condition | Voltage applied to | Earthed | Recloser |
|-----------|--------------------|------------------|----------|
| 1 | R | A, B, C, S, T, F | opened |
| 2 | S | A, B, C, R, T, F | opened |
| 3 | A | B, C, R, S, T, F | opened |
| 4 | B | A, C, R, S, T, F | opened |
| 5 | A, R | B, C, S, T, F | closed |
| 6 | B, S | A, C, R, T, F | closed |

*F = frame

Note

An alternate test procedure described in IEC 62271-1 (clause 6.2.5) was used in which nine test conditions are described. Three of the test conditions were omitted because the arrangement of the outer poles is symmetrical with respect to the centre pole and the frame.

3.2 Lightning impulse voltage test

Standard and date

Standard IEC 62271-111 / IEEE C37.60, clause 6.2.6.2

Test date(s) 7 April 2016

Environmental conditions

Ambient temperature 20 °C Ambient air pressure 1008 hPa
Humidity 9 g/m³

Correction factor for standard atmospheric conditions

Air pressure k_1 0,995 Total correction factor $K_t = k_1 \times k_2$ 0,976
Humidity k_2 0,980

The minimum correction factor that may be applied is 0,95

IEEE procedure

Positive and negative polarity

Air pressure k_d 0,995 and 0,995 Total correction factor positive (k_d / k_h) 0,980
Humidity k_h 1,015 and 1,000 Total correction factor negative (k_d / k_h) 0,995

No correction factors were applied.

Preconditioning

On client's request preconditioning impulses were applied prior to each test condition.

The sequences and voltage levels can be found in the table below.

| Condition | Polarity | Sequence and applied percentage of test voltage (%) |
|-----------|----------|--|
| 1 | positive | 50, 60, 70, 80, 80, 90, 95, 80, 90, 95, 100, 80, 90, 95, 100, 100 |
| | negative | 50, 60, 70, 80, 90, 95, 90, 95, 100, 100 |
| 2 | positive | 50, 60, 70, 80, 90, 95, 100, 100 |
| | negative | 50, 60, 70, 80, 90, 95, 100, 90, 95, 100, 80, 90, 95, 95, 100, 100 |
| 3 | positive | 50, 60, 70, 80, 80, 90, 90, 95, 100, 100 |
| | negative | 50, 60, 70, 70, 80, 90, 95, 100, 100 |
| 4 | positive | 50, 60, 70, 80, 90, 95, 100, 95, 100, 100 |
| | negative | 50, 60, 70, 80, 90, 95, 100, 100 |
| 5 | positive | 50, 70, 80, 90, 95, 100 |
| | negative | 50, 70, 80, 90, 95, 100 |
| 6 | positive | 50, 70, 90, 95, 100, |
| | negative | 50, 70, 80, 90, 95, 100 |

Characteristic test data

| Condition | Applied voltage (kV) | No. of impulses applied | No. of flashovers in self- restoring insulation | Breakdown of non-self- restoring insulation |
|-----------|-------------------------|----------------------------|--|--|
| 1 | 170 | +15 / -15 | 0 | No |
| 2 | 170 | +15 / -15 | 0 | No |
| 3 | 170 | +15 / -15 | 0 | No |
| 4 | 170 | +15 / -15 | 0 | No |
| 5 | 170 | +15 / -15 | 0 | No |
| 6 | 170 | +15 / -15 | 0 | No |

Note

- The test voltage was not corrected for atmospheric conditions, resulting in slightly higher test voltages than required and thus a more severe test.
- For test conditions, see clause 3.1 of this Certificate.

Requirements

The number of disruptive discharges shall not exceed two for each series of 15 impulses and no disruptive discharge shall occur on non-self-restoring insulation.

This is verified by at least 5 impulses without disruptive discharge following that impulse which caused the last disruptive discharge. When necessary, additional impulses shall be applied.

Result

The test object passed the tests.

3.3 Power-frequency voltage test

Standard and date

Standard IEC 62271-111 / IEEE C37.60, clause 6.2.6.1

Test date(s) 7 April 2016

Environmental conditions

| | | | |
|---------------------|-------|----------------------|----------|
| Ambient temperature | 20 °C | Ambient air pressure | 1008 hPa |
| | | Humidity | 52 % |

Correction factor for standard atmospheric conditionsAir pressure k_1 0,995 Total correction factor $K_t = k_1 \times k_2$ 0,972Humidity k_2 0,976

The minimum correction factor that may be applied is 0,95

IEEE procedure

*Positive and negative polarity*Air pressure k_d 0,995 Total correction factor (k_d / k_h) 0,974Humidity k_h 1,022

No correction factors were applied.

| Condition | Applied voltage, 50 Hz (kV) | Duration (min) | Observations |
|-----------|-----------------------------------|-------------------|----------------------------|
| 1 | 70 | 1 | No flashover, no breakdown |
| 2 | 70 | 1 | No flashover, no breakdown |
| 3 | 70 | 1 | No flashover, no breakdown |
| 4 | 70 | 1 | No flashover, no breakdown |
| 5 | 70 | 1 | No flashover, no breakdown |
| 6 | 70 | 1 | No flashover, no breakdown |

Note

- The test voltage was not corrected for atmospheric conditions, resulting in slightly higher test voltages than required and thus a more severe test.
- For test conditions, see clause 3.1 of this Certificate.

Requirements

No disruptive discharge shall occur.

Result

The test object passed the tests.

3.4 Wet power-frequency voltage test

Standard and date

Standard IEC 62271-111 / IEEE C37.60, clause 6.2.6.1

Test date(s) 8 April 2016

Environmental conditions

| | | | |
|---------------------|-------|----------------------|----------|
| Ambient temperature | 20 °C | Ambient air pressure | 1009 hPa |
| | | Humidity | 57 % |

Correction factor for standard atmospheric conditions

IEC procedure

| | | | | |
|--------------|-------------|-------------------------|-------------|-------|
| Air pressure | k_1 0,996 | Total correction factor | $K_t = k_1$ | 0,996 |
|--------------|-------------|-------------------------|-------------|-------|

The minimum correction factor that may be applied is 0,95

IEEE procedure

Positive and negative polarity

| | | | | |
|--------------|-------------|-------------------------|-------------|-------|
| Air pressure | k_d 0,996 | Total correction factor | $(k_d / 1)$ | 0,996 |
|--------------|-------------|-------------------------|-------------|-------|

No correction factors were applied.

Artificial rain conditionsResistivity (at 20 °C) $178 \pm 27 \Omega\text{m}$ Precipitation rate (vertical) $5 \pm 0,5 \text{ mm/min}$

Precipitation rate (horizontal) 0 mm/min

| Condition | Applied voltage, 50 Hz (kV) | Duration (second) | Observations |
|-----------|-----------------------------------|----------------------|----------------------------|
| 4 | 60 | 10 | no flashover, no breakdown |
| 5 | 60 | 10 | no flashover, no breakdown |

Note

- The test voltage was not corrected for atmospheric conditions, resulting in slightly higher test voltages than required and thus a more severe test.
- For test conditions, see clause 3.1 of this Certificate.

Requirements

No disruptive discharge shall occur.

Result

The test object passed the tests.

3.5 Additional lightning impulse voltage test

Standard and date

Standard client's request based on IEC 62271-111 / IEEE C37.60, clause 6.2.6.2

Test date(s) 8 April 2016

Environmental conditions

Ambient temperature 20 °C Ambient air pressure 1009 hPa
Humidity 10 g/m³

Correction factor for standard atmospheric conditions

Air pressure k_1 0,996 Total correction factor $K_t = k_1 \times k_2$ 0,991
Humidity k_2 0,995

The minimum correction factor that may be applied is 0,95

IEEE procedure

Positive and negative polarity

Air pressure k_d 0,996 and 0,996 Total correction factor positive (k_d / k_h) 0,985
Humidity k_h 1,011 and 1,000 Total correction factor negative (k_d / k_h) 0,996

No correction factors were applied.

Preconditioning

On clients request preconditioning impulses were applied prior to each test condition.

The sequences and voltage levels can be found in the table below.

| Condition | Polarity | Sequence and applied percentage of test voltage (%) |
|-----------|----------|---|
| 5 | positive | 50, 70, 80, 90, 95, 100 |
| | negative | 50, 70, 80, 90, 95, 100 |
| 6 | positive | 50, 70, 80, 90, 95, 100 |
| | negative | 50, 70, 80, 90, 95, 100 |

Characteristic test data

| Condition | Applied voltage (kV) | No. of impulses applied | No. of flashovers in self- restoring insulation | Breakdown of non-self- restoring insulation |
|-----------|-------------------------|----------------------------|--|--|
| 5 | 200 | +15 / -15 | 0 | No |
| 6 | 200 | +15 / -15 | 0 | No |

Note

- The test voltage was not corrected for atmospheric conditions, resulting in slightly higher test voltages than required and thus a more severe test.
- For test conditions, see clause 3.1 of this Certificate.

Requirements

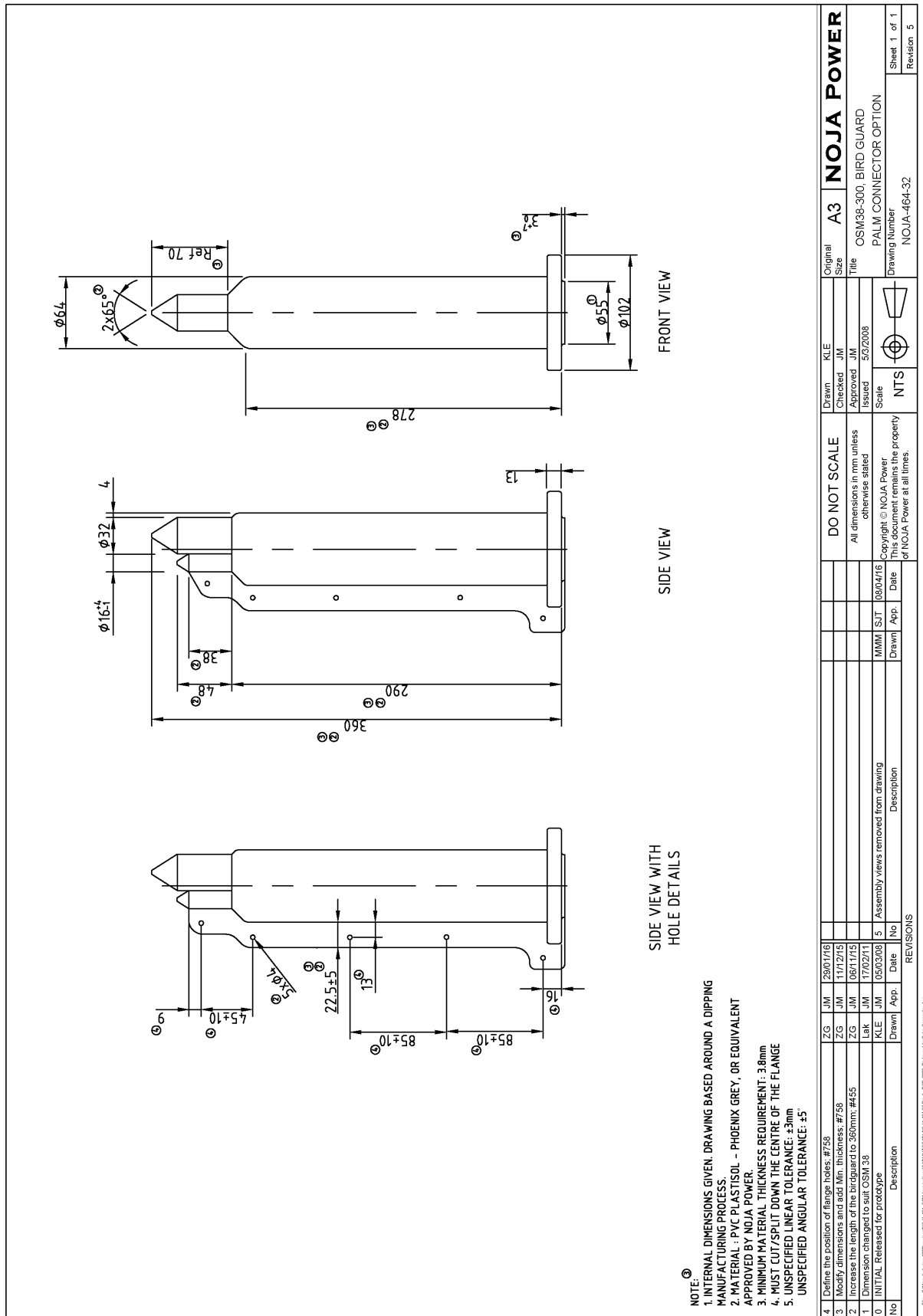
The number of disruptive discharges shall not exceed two for each series of 15 impulses and no disruptive discharge shall occur on non-self-restoring insulation.

This is verified by at least 5 impulses without disruptive discharge following that impulse which caused the last disruptive discharge. When necessary, additional impulses shall be applied.

Result

The test object passed the tests.





5 MEASUREMENT UNCERTAINTIES

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

| Measurement | Measurement uncertainty |
|---|--|
| Dielectric tests and impulse current tests: | |
| Peak value | $\leq 3 \%$ |
| Time parameters | $\leq 10 \%$ |
| Capacitance measurement | 0,3 % |
| Tan δ measurement | $\pm 0,5 \%$ $\pm 5 \times 10^{-5}$ |
| Partial discharge measurement: | |
| < 10 pC | 2 pC |
| 10 to 100 pC | 5 pC |
| > 100 pC | 20 % |
| Measurement of impedance | $\leq 1 \%$ |
| AC-resistance measurement | |
| Measurement of losses | $\leq 1 \%$ |
| Measurement of insulation resistance | $\leq 10 \%$ |
| Measurement of DC resistance: | |
| 1 to 5 $\mu\Omega$ | 1 % |
| 5 to 10 $\mu\Omega$ | 0,5 % |
| 10 to 200 $\mu\Omega$ | 0,2 % |
| Radio interference test | 2 dB |
| Calibration of current transformers | $2,2 \times 10^{-4} I_i/I_u$ and 290 μrad |
| Calibration of voltage transformers | $1,6 \times 10^{-4} U_i/U_u$ and 510 μrad |
| Measurement of conductivity | 5 % |
| Measurement of temperature: | |
| -50 to -40 °C | 3 K |
| -40 to 125 °C | 2 K |
| 125 to 150 °C | 3 K |
| Tensile test | 1 % |
| Sound level measurement | type 1 meter as per IEC 60651 and ANSI S1,4,1971 |
| Measurement of voltage ratio | 0,1 % |

6 PHOTOGRAPH OF TEST OBJECT



Test setup for the wet power-frequency voltage tests.