

TECHNICAL SPECIFICATION

**UHV AC transmission systems -
Part 301: On-site acceptance tests**

CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	8
2 Normative references	8
3 Terms and definitions	9
4 General	9
5 Power transformers	9
5.1 General	9
5.2 Leak testing with pressure (tightness test)	10
5.3 Winding resistance measurement	10
5.4 Ratio test	10
5.5 Polarity check	10
5.6 Insulation resistance test on each winding to earth and between windings including bushings	11
5.7 Dissipation factor ($\tan \delta$) and capacitance measurement on each winding to earth and between windings	11
5.8 Core and frame insulation check	11
5.9 Tests on bushings	11
5.9.1 Visual inspection	11
5.9.2 $\tan \delta$ and capacitance measurement	11
5.9.3 Tap withstand voltage	11
5.10 Insulating oil tests	11
5.11 Dissolved gas analysis (DGA) test	12
5.12 Excitation current measurements at reduced voltage	12
5.13 Frequency-response analysis (FRA)	12
5.14 Short-circuit impedance measurement at reduced current	12
5.15 Induced voltage tests with partial discharge measurement	12
5.16 Applied voltage tests	13
5.17 Measurement of short-circuit impedance and load loss (for an on-site assembly transformer)	13
5.18 Measurement of no-load loss and current (for an on-site assembly transformer)	13
6 Circuit-breakers (CB)	13
6.1 General	13
6.2 Dielectric test on main circuit	14
6.3 Dielectric test on auxiliary circuit	14
6.4 Measurement of the resistance of the main circuit	14
6.5 Checks after installation including gas tightness tests, gas quality, insulation resistance test	14
6.5.1 General	14
6.5.2 General checks	14
6.5.3 Checks of electrical circuits	14
6.5.4 Checks of the insulation and/or extinguishing fluid(s)	15
6.5.5 Checks on operating fluid(s), where filled or added to on-site	15
6.5.6 Site operations	15
6.6 Mechanical test and measurement	15
6.7 Test of accessories	16

7	GIS and GIL	16
7.1	General.....	16
7.2	Dielectric tests on the main circuits.....	17
7.3	Dielectric tests on auxiliary circuits	17
7.4	Measurement of the resistance of the main circuit.....	18
7.5	Gas tightness tests	18
7.6	Checks and verifications	18
7.7	Gas quality verifications	18
8	Surge arresters.....	19
8.1	General.....	19
8.2	Insulation resistance test	19
8.3	Insulation resistance test of the base insulator.....	19
8.4	Leakage current test	19
8.5	Checks and verifications	19
8.6	Tests of accessories	19
9	Voltage and current transformers.....	20
9.1	Capacitive voltage transformers (CVTs).....	20
9.1.1	General	20
9.1.2	Insulation resistance measurement of low voltage terminal to earth terminal	20
9.1.3	Capacitance and dissipation factor ($\tan \delta$) measurement	20
9.1.4	Tightness of the liquid-filled capacitor voltage dividers	20
9.1.5	Winding resistance measurement of electromagnetic units	21
9.1.6	Insulation resistance measurement of each component of electromagnetic units.....	21
9.1.7	Connection check between components of electromagnetic units	21
9.1.8	Tightness of electromagnetic units.....	21
9.1.9	Accuracy check (determination of error).....	21
9.1.10	Damper check	22
9.2	Bushing-type current transformers (CT)	22
9.2.1	General	22
9.2.2	Insulation resistance test	22
9.2.3	Resistance measurement	22
9.2.4	Applied voltage test on secondary windings.....	22
9.2.5	Determination of error and polarity check	22
9.2.6	Excitation test.....	22
10	Shunt reactors	23
10.1	General.....	23
10.2	Leak testing with pressure (tightness test)	23
10.3	Winding resistance measurement	23
10.4	Insulation resistance tests on each winding to earth and between windings including bushings	23
10.5	Dissipation factor ($\tan \delta$) and capacitance measurement on each winding to earth and between windings.....	24
10.6	Core and frame insulation check	24
10.7	Tests on bushings.....	24
10.7.1	Visual inspection	24
10.7.2	Tan δ and capacitance measurement.....	24
10.7.3	Tap withstand voltage	24

10.8	Insulating oil tests	24
10.9	DGA test	24
10.10	Applied voltage tests	24
11	Series compensators	25
11.1	General	25
11.2	Test on capacitors	25
11.3	Tests on metal oxide varistors	25
11.4	Tests on damping equipment	26
11.5	Tests on spark gaps	26
11.6	Tests on current transformers	27
11.7	Tests on by-pass switches	28
11.8	Tests on disconnectors	29
11.9	Tests on insulators	29
11.10	Tests on control and protection systems of series compensator	29
12	Insulators	30
12.1	General	30
12.2	On-site acceptance tests of suspension insulators	30
12.3	On-site acceptance tests of post insulators	30
13	Air-insulated disconnectors and earthing switches	30
13.1	Air-insulated disconnectors	30
13.1.1	General	30
13.1.2	Dielectric test on control and auxiliary circuits	30
13.1.3	Measurement of the resistance of the main circuit	31
13.1.4	Design and visual checks	31
13.1.5	Mechanical test	31
13.2	Air-insulated earthing switches	31
13.2.1	General	31
13.2.2	Design and visual checks	31
13.2.3	Dielectric tests on control and auxiliary circuits	31
13.2.4	Mechanical test	31
14	High-speed earthing switches (HSES)	31
14.1	General	31
14.2	Dielectric test on main circuit	31
14.3	Dielectric test on auxiliary circuit	32
14.4	Measurement of the resistance of the main circuit	32
14.5	Checks and verifications after installation including gas tightness tests, gas quality, insulation resistance test	32
14.6	Mechanical tests and measurements	32
14.7	Tests of accessories	32
14.8	CB and HSES operating sequence test	32
15	Protection and control system	32
15.1	General	32
15.2	Visual inspection	33
15.3	Wiring check	33
15.4	Insulation test	33
15.5	AC/DC power supply check	33
15.6	Device current and voltage sampling test	33
15.7	Binary input/output contact and signal check	33

15.8 Protection function verification 33

15.9 Control function verification..... 33

15.10 Auxiliary relay test 33

Bibliography 34

Figure 1 – Delay time of opening resistor and pre-insertion time of closing resistor..... 16

Table 1 – Requirements of insulating oil 12

Table 2 – Tan δ (%) of bushings..... 27

Table 3 – Limiting value of tan δ (%) 28

INTERNATIONAL ELECTROTECHNICAL COMMISSION

UHV AC transmission systems - Part 301: On-site acceptance tests

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TS 63042-301 has been prepared by IEC technical committee 122: UHV AC transmission systems. It is a Technical Specification.

This second edition cancels and replaces the first edition published in 2018. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) new subclause with measurement of short-circuit impedance and load loss for on-site assembly transformer has been added;
- b) new subclause with measurement of no-load loss and current for on-site assembly transformer has been added;
- c) on-site acceptance test requirement for GIL has been added;
- d) new clause with protection and control system on-site acceptance tests has been added.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
122/199/DTS	122/211/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

A list of all parts in the IEC 63042 series, published under the general title *UHV AC transmission systems*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

With the increase in voltage levels, the reliability and safety of high-voltage electric equipment is facing new challenges. There is a need to have consensus on a series of technical criteria and requirements for on-site acceptance tests for electrical equipment of ultra-high voltage (UHV) AC transmission systems exceeding 800 kV to detect the damages or abnormal conditions that can occur during the transportation and installation processes and to determine whether equipment can be put into operation reliably and safely for power systems.

This document proposes on-site acceptance tests, relevant test items, test methods, and evaluation criteria for transformers, circuit-breakers, gas insulated switchgear (GIS) and gas insulated transmission line (GIL), surge arresters, voltage and current transformers, shunt reactors, series compensators, insulators, disconnectors, earthing switches and high-speed earthing switches.

1 Scope

This part of IEC 63042, which is a technical specification, applies to on-site acceptance tests of electrical equipment with the highest voltages of AC transmission system exceeding 800 kV and its protection and control system.

The electrical equipment exceeding 800 kV includes the following items:

- power transformers;
- circuit-breakers (CBs);
- gas insulated switchgear (GIS);
- gas insulated transmission line (GIL);
- surge arresters;
- voltage and current transformers;
- shunt reactors;
- series compensators;
- insulators;
- disconnectors and earthing switches;
- high-speed earthing switches (HSES).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60076-18, *Power transformers – Part 18: Measurement of frequency response*

IEC 60137:2017, *Insulated bushings for alternating voltages above 1 000 V*

IEC 60383-1:2023, *Insulators for overhead lines with a nominal voltage above 1 000 V – Part 1: Ceramic or glass insulator units for a.c. systems – Definitions, test methods and acceptance criteria*

IEC 60480, *Specifications for the re-use of sulphur hexafluoride (SF₆) and its mixtures in electrical equipment*

IEC 62271-1:2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*
IEC 62271-1:2017/AMD1:2021

IEC 62271-4, *High-voltage switchgear and controlgear – Part 4: Handling procedures for gases for insulation and/or switching*

IEC 62271-100:2021, *High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers*
IEC 62271-100:2021/AMD1:2024

IEC 62271-102:2018, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

Bibliography

IEC 60071-1, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60076-1, *Power transformers – Part 1: General*

IEC 60076-3, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60143-1, *Series capacitors for power systems – Part 1: General*

IEC 60143-2, *Series capacitors for power systems – Part 2: Protective equipment for series capacitor banks*

IEC 60296, *Fluids for electrotechnical applications – Mineral insulating oils for electrical equipment*

IEC 60376, *Specification of technical grade sulphur hexafluoride (SF₆) and complementary gases to be used in its mixtures for use in electrical equipment*

IEC 60422, *Mineral insulating oils in electrical equipment – Supervision and maintenance guidance*

IEC 60599, *Mineral oil-filled electrical equipment in service – Guidance on the interpretation of dissolved and free gases analysis*

IEC 61869-5, *Instrument transformers – Part 5: Additional requirements for capacitor voltage transformers*

IEC 62271-109:2019, *High-voltage switchgear and controlgear – Part 109: Alternating-current series capacitor by-pass switches*

IEC 62271-112:2021, *High-voltage switchgear and controlgear – Part 112: Alternating current high-speed earthing switches for secondary arc extinction on transmission lines*
