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Date: 17 July 2017

Origin: International

**Latest date for receipt of comments: 04 October 2017**

Project No. 2016/02444

Responsible committee: PEL/38 Instrument transformers

Interested committees:

Title: Draft BS EN 61869-1 Ed 2.0 Instrument transformers. Part 1: General requirements.

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

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- iii) requires additional national guidance or information

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## Introduction

This draft standard is based on European discussions in which the UK has taken an active part. Your comments on this draft are welcome and will assist in the preparation of the consequent British Standard. Comment is particularly welcome on national, legislative or similar deviations that may be necessary.

Even if this draft standard is not approved by the UK, if it receives the necessary support in Europe, the UK will be obliged to publish the official English Language text unchanged as a British Standard and to withdraw any conflicting standard.

## UK Vote

Please indicate whether you consider the UK should submit a negative (with reasons) or positive vote on this draft.

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## Template for comments and secretariat observations

|                  |                        |
|------------------|------------------------|
| Date: xx/xx/20xx | Document: ISO/DIS xxxx |
|------------------|------------------------|

| 1  | 2                                          | (3)                          | 4               | 5                                                                                                                                  | (6)                                                                      | 7                                                  |
|----|--------------------------------------------|------------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------|
| MB | Clause No./ Subclause No./Annex (e.g. 3.1) | Paragraph/Figure/ Table/Note | Type of comment | Comment (justification for change) by the MB                                                                                       | Proposed change by the MB                                                | Secretariat observations on each comment submitted |
|    | 3.1                                        | Definition 1                 | ed              | Definition is ambiguous and needs clarifying.                                                                                      | Amend to read '...so that the mains connector to which no connection...' |                                                    |
|    | 6.4                                        | Paragraph 2                  | te              | The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK. | Delete reference to UV photometer.                                       |                                                    |



**38/548/CD**

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

**IEC 61869-1 ED2**

DATE OF CIRCULATION:

**2017-07-14**

CLOSING DATE FOR COMMENTS:

**2017-11-03**

SUPERSEDES DOCUMENTS:

**38/516/CD,38/533A/CC**

IEC TC 38 : INSTRUMENT TRANSFORMERS

SECRETARIAT:

Italy

SECRETARY:

Mr Filippo Frugoni

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 10,TC 13,SC 17C,TC 33,TC 85,TC 95,TC 115

PROPOSED HORIZONTAL STANDARD:



Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☒ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

**Instrument transformers - Part 1: General requirements**

NOTE FROM TC/SC OFFICERS:

# CONTENTS

|    |                                                                          |  |    |
|----|--------------------------------------------------------------------------|--|----|
| 1  |                                                                          |  |    |
| 2  |                                                                          |  |    |
| 3  | FOREWORD.....                                                            |  | 7  |
| 4  | INTRODUCTION.....                                                        |  | 10 |
| 5  | 1 Scope.....                                                             |  | 13 |
| 6  | 2 Normative references .....                                             |  | 13 |
| 7  | 3 Terms and definitions .....                                            |  | 15 |
| 8  | 3.1 General definitions.....                                             |  | 15 |
| 9  | 3.2 Definitions related to voltage and dielectric aspects .....          |  | 16 |
| 10 | 3.3 Definitions related to current ratings .....                         |  | 18 |
| 11 | 3.4 Definitions related to accuracy .....                                |  | 18 |
| 12 | 3.5 Definitions related to other ratings .....                           |  | 20 |
| 13 | 3.6 Definitions related to gas insulation .....                          |  | 20 |
| 14 | 3.7 Index of abbreviations .....                                         |  | 22 |
| 15 | 4 Normal and special service conditions .....                            |  | 22 |
| 16 | 4.1 General.....                                                         |  | 22 |
| 17 | 4.2 Normal service conditions .....                                      |  | 22 |
| 18 | 4.2.1 Ambient air temperature .....                                      |  | 22 |
| 19 | 4.2.2 Altitude .....                                                     |  | 23 |
| 20 | 4.2.3 Vibrations or earth tremors .....                                  |  | 23 |
| 21 | 4.2.4 Other service conditions for indoor instrument transformers.....   |  | 23 |
| 22 | 4.2.5 Other service conditions for outdoor instrument transformers ..... |  | 23 |
| 23 | 4.3 Special service conditions.....                                      |  | 24 |
| 24 | 4.3.1 General .....                                                      |  | 24 |
| 25 | 4.3.2 Altitude .....                                                     |  | 24 |
| 26 | 4.3.3 Ambient temperature .....                                          |  | 24 |
| 27 | 4.3.4 Vibrations or earth tremors .....                                  |  | 24 |
| 28 | 4.3.5 Earthquakes .....                                                  |  | 24 |
| 29 | 5 Ratings.....                                                           |  | 24 |
| 30 | 5.1 General.....                                                         |  | 24 |
| 31 | 5.2 Voltage ratings.....                                                 |  | 25 |
| 32 | 5.2.1 Highest voltage for equipment .....                                |  | 25 |
| 33 | 5.2.2 System voltage .....                                               |  | 26 |
| 34 | 5.2.3 System earthing.....                                               |  | 26 |
| 35 | 5.3 Current ratings.....                                                 |  | 26 |
| 36 | 5.4 Dielectric ratings .....                                             |  | 26 |
| 37 | 5.4.1 General .....                                                      |  | 26 |
| 38 | 5.4.2 Rated primary terminal insulation level .....                      |  | 26 |
| 39 | 5.4.3 Other requirements for primary terminals insulation .....          |  | 27 |
| 40 | 5.4.4 Between-section insulation requirements .....                      |  | 28 |
| 41 | 5.4.5 Insulation requirements for secondary terminals .....              |  | 28 |
| 42 | 5.5 Rated frequency .....                                                |  | 28 |
| 43 | 5.6 Output ratings .....                                                 |  | 28 |
| 44 | 5.7 Rated accuracy class .....                                           |  | 28 |
| 45 | 6 Design and construction .....                                          |  | 28 |
| 46 | 6.1 Requirements for liquids used in equipment.....                      |  | 28 |
| 47 | 6.1.1 General .....                                                      |  | 28 |

|    |        |                                                                                                                                             |    |
|----|--------|---------------------------------------------------------------------------------------------------------------------------------------------|----|
| 48 | 6.1.2  | Liquid quality .....                                                                                                                        | 28 |
| 49 | 6.1.3  | Liquid level device .....                                                                                                                   | 29 |
| 50 | 6.1.4  | Liquid tightness .....                                                                                                                      | 29 |
| 51 | 6.2    | Requirements for gases used in equipment.....                                                                                               | 29 |
| 52 | 6.2.1  | General .....                                                                                                                               | 29 |
| 53 | 6.2.2  | Gas quality .....                                                                                                                           | 29 |
| 54 | 6.2.3  | Gas monitoring device .....                                                                                                                 | 29 |
| 55 | 6.2.4  | Gas tightness .....                                                                                                                         | 29 |
| 56 | 6.2.5  | Pressure relief device .....                                                                                                                | 30 |
| 57 | 6.3    | Requirements for solid materials used in equipment .....                                                                                    | 30 |
| 58 | 6.4    | Requirements for temperature rise of parts and components.....                                                                              | 30 |
| 59 | 6.4.1  | General .....                                                                                                                               | 30 |
| 60 | 6.4.2  | Influence of altitude on temperature rise .....                                                                                             | 31 |
| 61 | 6.5    | Requirements for earthing of equipment.....                                                                                                 | 32 |
| 62 | 6.5.1  | General .....                                                                                                                               | 32 |
| 63 | 6.5.2  | Earthing of the enclosure .....                                                                                                             | 32 |
| 64 | 6.5.3  | Electrical continuity.....                                                                                                                  | 32 |
| 65 | 6.6    | Requirements for the external insulation .....                                                                                              | 33 |
| 66 | 6.6.1  | Pollution .....                                                                                                                             | 33 |
| 67 | 6.6.2  | Altitude .....                                                                                                                              | 33 |
| 68 | 6.7    | Mechanical requirements .....                                                                                                               | 33 |
| 69 | 6.8    | Multiple chopped impulses on primary terminals .....                                                                                        | 34 |
| 70 | 6.9    | Internal arc fault protection requirements .....                                                                                            | 34 |
| 71 | 6.10   | Degrees of protection by enclosures .....                                                                                                   | 35 |
| 72 | 6.10.1 | General .....                                                                                                                               | 35 |
| 73 | 6.10.2 | Protection of persons against access to hazardous parts and<br>protection of the equipment against ingress of solid foreign<br>objects..... | 35 |
| 76 | 6.10.3 | Protection against ingress of water .....                                                                                                   | 36 |
| 77 | 6.10.4 | Indoor instrument transformers .....                                                                                                        | 36 |
| 78 | 6.10.5 | Outdoor instrument transformers .....                                                                                                       | 36 |
| 79 | 6.10.6 | Protection of equipment against mechanical impact under<br>normal service conditions .....                                                  | 36 |
| 81 | 6.11   | Electromagnetic Compatibility (EMC) .....                                                                                                   | 36 |
| 82 | 6.11.1 | General .....                                                                                                                               | 36 |
| 83 | 6.11.2 | Requirement for Radio Interference Voltage (RIV) .....                                                                                      | 37 |
| 84 | 6.11.3 | Requirements for immunity .....                                                                                                             | 37 |
| 85 | 6.11.4 | Requirement for transmitted overvoltage .....                                                                                               | 37 |
| 86 | 6.12   | Corrosion .....                                                                                                                             | 38 |
| 87 | 6.13   | Markings .....                                                                                                                              | 38 |
| 88 | 6.13.1 | Terminal markings .....                                                                                                                     | 38 |
| 89 | 6.13.2 | Rating plate markings .....                                                                                                                 | 39 |
| 90 | 6.14   | Fire hazard .....                                                                                                                           | 39 |
| 91 | 6.15   | Pressure withstand of gas-filled enclosures .....                                                                                           | 39 |
| 92 | 7      | Tests .....                                                                                                                                 | 40 |
| 93 | 7.1    | General.....                                                                                                                                | 40 |
| 94 | 7.1.1  | Classification of tests.....                                                                                                                | 40 |
| 95 | 7.1.2  | List of tests .....                                                                                                                         | 40 |
| 96 | 7.1.3  | Sequence of tests .....                                                                                                                     | 41 |

|     |        |                                                                         |    |
|-----|--------|-------------------------------------------------------------------------|----|
| 97  | 7.2    | Type tests .....                                                        | 42 |
| 98  | 7.2.1  | General .....                                                           | 42 |
| 99  | 7.2.2  | Temperature rise test .....                                             | 43 |
| 100 | 7.2.3  | Impulse voltage withstand test on primary terminals .....               | 44 |
| 101 | 7.2.4  | Wet test for outdoor type transformers .....                            | 46 |
| 102 | 7.2.5  | Electromagnetic Compatibility (EMC) tests .....                         | 46 |
| 103 | 7.2.6  | Test for accuracy .....                                                 | 50 |
| 104 | 7.2.7  | Verification of the degree of protection by enclosures .....            | 50 |
| 105 | 7.2.8  | Enclosure tightness test at ambient temperature .....                   | 51 |
| 106 | 7.2.9  | Proof test for the enclosure .....                                      | 51 |
| 107 | 7.2.10 | Mechanical tests .....                                                  | 51 |
| 108 | 7.2.11 | Multiple chopped impulse test on primary terminals .....                | 53 |
| 109 | 7.3    | Routine tests .....                                                     | 54 |
| 110 | 7.3.1  | Power-frequency voltage withstand tests on primary terminals .....      | 54 |
| 111 | 7.3.2  | Partial discharge measurement .....                                     | 54 |
| 112 | 7.3.3  | Power-frequency voltage withstand tests between sections .....          | 57 |
| 113 | 7.3.4  | Insulation tests on secondary terminals .....                           | 57 |
| 114 | 7.3.5  | Test for accuracy .....                                                 | 57 |
| 115 | 7.3.6  | Verification of markings .....                                          | 57 |
| 116 | 7.3.7  | Enclosure tightness test at ambient temperature .....                   | 58 |
| 117 | 7.3.8  | Pressure test for the enclosure .....                                   | 58 |
| 118 | 7.3.9  | Measurement of capacitance and dielectric dissipation factor .....      | 58 |
| 119 | 7.4    | Special tests .....                                                     | 59 |
| 120 | 7.4.1  | Internal arc fault test .....                                           | 59 |
| 121 | 7.4.2  | Enclosure tightness tests at low and high temperatures .....            | 59 |
| 122 | 7.4.3  | Corrosion test .....                                                    | 60 |
| 123 | 7.4.4  | Fire hazard test .....                                                  | 61 |
| 124 | 7.4.5  | Thermo-mechanical endurance test .....                                  | 61 |
| 125 | 7.5    | Commissioning tests .....                                               | 61 |
| 126 | 7.5.1  | Gas dew point test .....                                                | 61 |
| 127 | 7.6    | Sample tests .....                                                      | 62 |
| 128 | 8      | Rules for transport, storage, erection, operation and maintenance ..... | 62 |
| 129 | 8.1    | General .....                                                           | 62 |
| 130 | 8.2    | Conditions during transport, storage and installation .....             | 62 |
| 131 | 8.3    | Installation .....                                                      | 62 |
| 132 | 8.3.1  | General .....                                                           | 62 |
| 133 | 8.3.2  | Unpacking and lifting .....                                             | 62 |
| 134 | 8.3.3  | Assembly .....                                                          | 62 |
| 135 | 8.3.4  | Mounting .....                                                          | 63 |
| 136 | 8.3.5  | Connections .....                                                       | 63 |
| 137 | 8.3.6  | Final installation inspection .....                                     | 63 |
| 138 | 8.4    | Operation .....                                                         | 63 |
| 139 | 8.5    | Maintenance .....                                                       | 64 |
| 140 | 8.5.1  | General .....                                                           | 64 |
| 141 | 8.5.2  | Responsibilities for the manufacturer .....                             | 64 |
| 142 | 8.5.3  | Responsibilities for the purchaser .....                                | 64 |
| 143 | 8.6    | Failure report .....                                                    | 65 |
| 144 | 9      | Safety .....                                                            | 65 |
| 145 | 10     | Influence of products on the natural environment .....                  | 65 |

|     |                                                                                      |    |
|-----|--------------------------------------------------------------------------------------|----|
| 146 | Annex A (normative) Identification of test specimen .....                            | 66 |
| 147 | A.1 General.....                                                                     | 66 |
| 148 | A.2 Data.....                                                                        | 66 |
| 149 | A.3 Drawings.....                                                                    | 66 |
| 150 | Annex B (informative) Recommendation for contents of failure reports.....            | 67 |
| 151 | B.1 General.....                                                                     | 67 |
| 152 | B.2 Content.....                                                                     | 67 |
| 153 | Annex C (informative) Fire hazard .....                                              | 69 |
| 154 | C.1 Fire hazard .....                                                                | 69 |
| 155 | C.2 Fire hazard test.....                                                            | 69 |
| 156 | Annex D (informative) Sample test.....                                               | 70 |
| 157 | D.1 Sample test definition .....                                                     | 70 |
| 158 | Annex E (informative) Corrosion: Information regarding service conditions and        |    |
| 159 | recommended test requirements.....                                                   | 71 |
| 160 | E.1 Introduction.....                                                                | 71 |
| 161 | E.2 Recommendation for minimum requirements.....                                     | 71 |
| 162 | E.3 Recommended test requirements.....                                               | 71 |
| 163 | Annex F (informative) Technique used in temperature rise test of transformers to     |    |
| 164 | determine the thermal time constant by an experimental estimation.....               | 72 |
| 165 | Annex G (informative) Guidance for the extension of validity of type tests of        |    |
| 166 | instrument transformers.....                                                         | 74 |
| 167 | G.1 General.....                                                                     | 74 |
| 168 | G.2 Information needed for extension of type test validity .....                     | 74 |
| 169 | G.3 Application of extension criteria .....                                          | 75 |
| 170 | G.3.1 Dielectric tests.....                                                          | 75 |
| 171 | G.3.2 Temperature rise tests.....                                                    | 75 |
| 172 | G.3.3 Short-time and peak withstand current tests (current transformers) .....       | 76 |
| 173 | G.3.4 Internal arc fault tests.....                                                  | 76 |
| 174 | G.3.5 Multiple chopped impulse test .....                                            | 77 |
| 175 | Annex H (informative) Guidance for the calculation of equivalent diameter in case of |    |
| 176 | irregular shape of insulating part .....                                             | 78 |
| 177 | H.1 General.....                                                                     | 78 |
| 178 | H.2 Current transformers and earthed voltage transformers .....                      | 78 |
| 179 | H.3 Unearthed voltage transformers .....                                             | 79 |
| 180 | Bibliography.....                                                                    | 80 |
| 181 |                                                                                      |    |
| 182 | Figure 1 – Altitude correction factor for the temperature rise.....                  | 32 |
| 183 | Figure 2 – Transmitted overvoltage measurement: Test impulse waveforms .....         | 38 |
| 184 | Figure 3 – Sequence of tests .....                                                   | 42 |
| 185 | Figure 4 – RIV measuring circuit.....                                                | 47 |
| 186 | Figure 5 – Transmitted overvoltage measurement: general test configuration .....     | 49 |
| 187 | Figure 6 – Transmitted overvoltage measurement: test circuit and GIS Test            |    |
| 188 | configuration (CT).....                                                              | 49 |
| 189 | Figure 7 – Test circuit for partial discharge measurement .....                      | 54 |
| 190 | Figure 8 – Alternative circuit for partial discharge measurement .....               | 55 |
| 191 | Figure 9 – Example of balanced test circuit for partial discharge measurement.....   | 55 |
| 192 | Figure 10 – Example of calibration circuit for partial discharge measurement.....    | 56 |

|     |                                                                                            |    |
|-----|--------------------------------------------------------------------------------------------|----|
| 193 | Figure 11 – Voltage profile for partial discharge measurement .....                        | 57 |
| 194 | Figure F.1 – Graphical extrapolation to ultimate temperature rise .....                    | 73 |
| 195 | Figure H.1 – Examples of MV CT's and earthed VT's .....                                    | 78 |
| 196 | Figure H.2 – Examples of unearthed VT's .....                                              | 79 |
| 197 |                                                                                            |    |
| 198 | Table 1 – Temperature categories .....                                                     | 23 |
| 199 | Table 2 – Rated primary terminal insulation levels for instrument transformers .....       | 25 |
| 200 | Table 3 – Partial discharge test voltages and permissible levels .....                     | 27 |
| 201 | Table 4 – Maximum values of $\tan \delta$ .....                                            | 28 |
| 202 | Table 5 – Permissible temporary leakage rates for gas systems .....                        | 30 |
| 203 | Table 6 – Limits of temperature and temperature rise for various parts, materials and      |    |
| 204 | dielectrics of instrument transformers .....                                               | 31 |
| 205 | Table 7 – Static withstand test loads .....                                                | 34 |
| 206 | Table 8 – Maximum gas-in-oil level in instrument transformers .....                        | 34 |
| 207 | Table 9 – Arc fault duration and performance criteria .....                                | 35 |
| 208 | Table 10 – Transmitted overvoltage limits .....                                            | 37 |
| 209 | Table 11 – List of tests .....                                                             | 40 |
| 210 | Table 12 – Gas type and pressure during type, routine and special tests .....              | 41 |
| 211 | Table 13 – Modalities of application of the test loads to be applied to the primary        |    |
| 212 | terminals .....                                                                            | 52 |
| 213 | Table C.1 – Fire hazard of electrotechnical products .....                                 | 69 |
| 214 | Table G.1 – Extension criteria for dielectric withstand performance .....                  | 75 |
| 215 | Table G.2 – Extension criteria for temperature rise performance .....                      | 75 |
| 216 | Table G.3 – Extension criteria for short-time and peak withstand current performance ..... | 76 |
| 217 | Table G.4 – Extension criteria for internal arc fault tests .....                          | 76 |
| 218 | Table G.5 – Extension criteria for multiple chopped impulse test .....                     | 77 |
| 219 |                                                                                            |    |
| 220 |                                                                                            |    |

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## INSTRUMENT TRANSFORMERS –

## Part 1: General requirements

## FOREWORD

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International Standard IEC 61869-1 has been prepared by IEC technical committee 38: Instrument transformers.

This second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

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

The text of this standard is based on the following documents:

| FDIS       | Report on voting |
|------------|------------------|
| XX/XX/FDIS | XX/XX/RVD        |

273  
274 Full information on the voting for the approval of this standard can be found in the report on  
275 voting indicated in the above table.

276 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

277 A list of all parts in the IEC 61869 series, published under the general title *Instrument transformers*,  
278 can be found on the IEC website.

279 An overview of the planned set of standards at the date of publication of this document is  
280 given below. The updated list of standards issued by IEC TC 38 is available at the website:  
281 [www.iec.ch](http://www.iec.ch)

| PRODUCT FAMILY STANDARDS                                           |                                                                                         | PRODUCT STANDARD | PRODUCTS                                                                                                |
|--------------------------------------------------------------------|-----------------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------------------------------|
| <b>61869-1</b><br>GENERAL REQUIREMENTS FOR INSTRUMENT TRANSFORMERS |                                                                                         | 61869-2          | ADDITIONAL REQUIREMENTS FOR CURRENT TRANSFORMERS                                                        |
|                                                                    |                                                                                         | 61869-3          | ADDITIONAL REQUIREMENTS FOR INDUCTIVE VOLTAGE TRANSFORMERS                                              |
|                                                                    |                                                                                         | 61869-4          | ADDITIONAL REQUIREMENTS FOR COMBINED TRANSFORMERS                                                       |
|                                                                    |                                                                                         | 61869-5          | ADDITIONAL REQUIREMENTS FOR CAPACITIVE VOLTAGE TRANSFORMERS                                             |
|                                                                    | <b>61869-6</b><br>ADDITIONAL GENERAL REQUIREMENTS FOR LOW POWER INSTRUMENT TRANSFORMERS | 61869-7          | ADDITIONAL REQUIREMENTS FOR ELECTRONIC VOLTAGE TRANSFORMERS                                             |
|                                                                    |                                                                                         | 61869-8          | ADDITIONAL REQUIREMENTS FOR ELECTRONIC CURRENT TRANSFORMERS                                             |
|                                                                    |                                                                                         | 61869-9          | DIGITAL INTERFACE FOR INSTRUMENT TRANSFORMERS                                                           |
|                                                                    |                                                                                         | 61869-10         | ADDITIONAL REQUIREMENTS FOR LOW-POWER PASSIVE CURRENT TRANSFORMERS                                      |
|                                                                    |                                                                                         | 61869-11         | ADDITIONAL REQUIREMENTS FOR LOW POWER PASSIVE VOLTAGE TRANSFORMERS                                      |
|                                                                    |                                                                                         | 61869-12         | ADDITIONAL REQUIREMENTS FOR COMBINED ELECTRONIC INSTRUMENT TRANSFORMER OR COMBINED PASSIVE TRANSFORMERS |
|                                                                    |                                                                                         | 61869-13         | STAND ALONE MERGING UNIT                                                                                |
|                                                                    |                                                                                         | 61869-14         | ADDITIONAL REQUIREMENTS FOR CURRENT TRANSFORMERS FOR DC APPLICATIONS                                    |
|                                                                    |                                                                                         | 61869-15         | ADDITIONAL REQUIREMENTS FOR VOLTAGE TRANSFORMERS FOR DC APPLICATIONS                                    |

282  
283 The committee has decided that the contents of this publication will remain unchanged until  
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285 related to the specific publication. At this date, the publication will be

- 286 • reconfirmed,  
287 • withdrawn,  
288 • replaced by a revised edition, or  
289 • amended.

290

291 The National Committees are requested to note that for this publication the stability date  
292 is 20XX.

293 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED  
294 AT THE PUBLICATION STAGE.

295

296

297

## INTRODUCTION

298 This standard is the first revision of the standard IEC 61869-1, defining common requirements  
299 for instrument transformers, whatever the type (CT, VT ...) or the technology.

300 The revision has been decided by the TC38 general meeting in November 2014, and has  
301 been officialised by the review report 38/497/RR.

302 To help its comprehension, this present introduction highlights the important modifications  
303 from the previous document issued in 2007.

304 In the document, technical modifications are marked with a red line on the left side of the  
305 page.

306 • Scope: this document concerns only equipment for applications > 1 kV. LV equipment  
307 are covered by IEC 61869-201.

308 • Definitions:

309 – check consistency with the IEV definitions.

310 – some definitions related to CT's or VT's have been introduced, as they are common  
311 definitions for different documents in the IEC 61869 series.

312 – New definition of “phase error”, more generic than the phase displacement  
313 considering the general case where the phase error introduced by the instrument  
314 transformer can include a constant value related to the sensor technology (ex  
315 Rogowski core) or to the signal processing.

316 – Definition of the power factor, permissible leakage rate and sniffing (missing).

317 – modification of some acronyms to be consistent with the IEC 60027-1:  $K_r$ ,  $f_r$ .

318 • Ratings:

319 – More logical clause repartition, between voltage ratings, current ratings (clause  
320 number has been prepared for the different specific standards) and dielectric ratings.

321 – Table2: addition of the EHV levels to be consistent with other equipment.

322 – System voltage and system earthing have been transferred from chapter 4 to chapter  
323 5, as these are not service conditions

324 – Chopped lightning impulse is now applicable for all kind of IT's with  $U_m > 72,5$  kV

325 For gas-insulated IT's, it will be performed at rated filling pressure.

326 This is critical to test voltage repartition on VT windings, voltage dividers as well as  
327 on graded insulation.

328 – Criteria for capacitance and  $\tan\delta$  has been moved to the chapter “rating” instead of  
329 chapter 6 for consistency of the dielectric requirement. A table 4 has been added for  
330 maximum values of  $\tan\delta$  depending on the insulation technology.

331 – Insulation requirements for secondary terminals: additionally to the actual 3 kV AC  
332 withstand test, a measurement of the DC insulation resistance at 1 kV minimum is  
333 requested. This was introduced for consistency with IEEE and the request from many  
334 customers. It also gives a more accurate measurement of the quality of the insulation  
335 than the previous “pass or fail” criteria.

336 • Design and construction

337 – Table 6 (previously table 5) has been adapted to be consistent with revised IEC  
338 60085. Note that, in accordance with previous standards, the maximum allowed  
339 temperature rise has been reduced by 5K to consider the fact that resistance  
340 measurement method gives an average temperature instead of hot spot.

- Pollution: instead of the former table 6 specifying creepage distance, we are now referring to the new edition of IEC 60815 series. This new edition refers to voltage phase-to-ground, and we need also to consider the correction factor according to the diameter. An Annex H defines some rules to calculate the equivalent average diameter in case of irregular shape of the insulating part.
- Altitude: direct reference is made to the IEC 60071-2 to avoid any incoherence.
- Mechanical requirement: the table 7 has been completed to consider EHV applications.
- Multiple chopped impulse test: definition of maximum gas-in-oil level before and after test.
- Transmitted overvoltage: both wave shapes are applicable for any type of insulation.
- Markings: add requirements for the terminal markings. This is needed for right structure of the documents for specific requirements.
- Basic requirement for the pressure withstand of gas-filled enclosure, referring to the IEC 62271-203 for determination of the design pressure.

#### • Type of tests

- The definition of special test has been clarified as optional test related to optional requirements. Mandatory tests for optional requirements are considered as type tests (Ex: multiple chopped impulse test).
- A new type of tests has been added: commissioning tests, to be carried out on-site.
- A sequence of tests has been defined for common tests and shall be completed or adapted in each specific standard.
- Transmitted overvoltage test and mechanical test have been moved from special tests to type tests. These requirements are considered as sufficiently important to validate the product design on a mandatory basis.
- Chopped wave impulse test is now a type test, and is included in the dielectric tests. This is critical to test voltage repartition on VT windings, voltage dividers as well as on any graded insulation. As a conclusion, it is also applicable to GIS VT's. This is also needed to be consistent with IEC 61869-11, and certain other IEC and IEEE standards. Practically, this test is carried out together with the impulse test.
- Measurement of C and  $\tan\delta$  has been moved from special tests to routine tests. When applicable, this is a basic test for measurement of the quality of insulation.

#### • Type tests

- A new annex G (informative) gives guidance for the extension of validity of type tests of an instrument transformer to another one of the same product range, but with a different set of ratings or different arrangements of components.
- Temperature rise test: more accurate definition of the test duration, consistent with Part 2, but applicable to almost all types of instrument transformers. If not applicable, it shall be specified in each specific standard.
- Lightning impulse test: same procedure (15 impulses) for all instrument transformers, whatever the voltage level. The previous specification of 3 impulses above 300 kV has no serious technical background was specific for instrument transformer standard.
- Switching impulse test: to be performed in both polarities. This is needed to be consistent with other IEC standards and is necessary for testing of gas-insulated instrument transformers.
- Chopped impulse: no modification except the move to the type test chapter
- Transmitted overvoltage test: moved to type test chapter. Small modification on the test circuit and some requirements about the provisions to be taken.

- 391 – Test for accuracy: the accuracy must be verified with regards to the temperature  
392 range and guaranteed for the whole frequency range as well as any transformer  
393 position.
- 394 – Verification of the degree of protection by enclosures: some clarifications on the test  
395 procedure.
- 396 – Mechanical test: moved to type test chapter. As the wind load on the IT represents  
397 30 to 40% of the total load, it is permitted to apply this load directly on the  
398 transformer head instead of the terminals. Three possible test procedures are  
399 considered.
- 400 – Multiple chopped impulse test: moved to the type test chapter, because of the new  
401 definition of special tests.
- 402 • Routine tests
- 403 – Partial discharge measurement: definition of the voltage profile.  
404 The measurement of PD inception voltage and extinction voltage shall be recorded.
- 405 – Insulation test on secondary terminals (new name): addition of the measurement of  
406 the DC insulation resistance at 1 kV DC.
- 407 – Tightness test for liquid insulation: clarification of the test procedure. A test time of  
408 24 h under pressure is defined to let time for the leakage to appear.
- 409 – Measurement of C and  $\tan\delta$ : moved to routine test chapter. Definition of  $\tan\delta$  criteria  
410 depending on the insulation material.
- 411 • Special tests  
412 Addition of a new test for resin insulated instrument transformers operating at low  
413 temperature. This is needed to check for the absence of cracks or partial discharges  
414 after 5 temperature cycles between the ambient temperature and the minimum  
415 temperature.
- 416 • Commissioning tests  
417 The gas dew point test has been moved to commissioning tests. The reason is that the  
418 measurement of gas humidity only makes sense with the final filling gas. After routine  
419 test, the transformers are transported with reduced pressure.
- 420 • Rules for transport, storage, erection, operation and maintenance: All the important  
421 rules are mandatory and have been transferred from the informative annex to the  
422 standard requirements.
- 423

## INSTRUMENT TRANSFORMERS

### Part 1: General requirements

#### 1 Scope

This International Standard is applicable to newly manufactured instrument transformers for system voltage higher than 1 kV AC and 1.5 kV DC, with analogue or digital output for use with electrical measuring instruments or electrical protective devices, either for DC application, or having rated frequencies from 15 Hz to 400 Hz.

The general requirements for instrument transformers for applications in LV systems are considered in the standard IEC 61869-201.

This standard is a product family standard and covers general requirements only. For each kind of instrument transformer, the product standard is composed by this standard and the relevant specific standard.

#### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60060-1: *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-2-11: *Basic environmental testing procedures – Part 2: Tests – Test Ka: Salt mist*

IEC 60068-2-17: *Basic environmental testing procedures – Part 2: Tests - Test Q: Sealing*

IEC 60068-2-75: *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests.*

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

IEC 60085: *Electrical insulation – Thermal evaluation and designation*

IEC 60270: *High-voltage test techniques – Partial discharge measurements*

IEC 60296: *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

IEC 60376: *Specification of technical grade sulphur hexafluoride (SF<sub>6</sub>) for use in electrical equipment*

IEC 60417: *Graphical symbols for use on equipment*

IEC 60455 (all parts): *Resin based reactive compounds used for electrical insulation*

IEC 60480: *Guidelines for the checking and treatment of sulphur hexafluoride (SF<sub>6</sub>) taken from electrical equipment and specification for its re-use*

IEC 60529: *Degrees of protection provided by enclosures (IP code)*

- 459 IEC 60567: *Oil-filled electrical equipment – Sampling of gases and of oil for analysis of free*  
460 *and dissolved gases – Guidance*
- 461 IEC 60695-1-1: *Fire hazard testing – Part 1-1: Guidance for assessing the fire hazard of*  
462 *electrotechnical products - General guidelines*
- 463 IEC 60695-1-30: *Fire hazard testing – Part 1-30: Guidance for assessing the fire hazard of*  
464 *electrotechnical products – Use of preselection testing procedures*
- 465 IEC 60695-7-1: *Fire hazard testing – Part 7-1: Toxicity of fire effluent - General guidance*
- 466 IEC 60721-3-3: *Classification of environmental conditions – Part 3-3: Classification of groups*  
467 *of environmental parameters and their severities – Stationary use of weather protected*  
468 *locations*
- 469 IEC 60721-3-4: *Classification of environmental conditions – Part 3: Classification of groups of*  
470 *environmental parameters and their severities – Section 4: Stationary use at non-weather*  
471 *protected locations*
- 472 IEC 60815: *Guide for the selection of insulators in respect of polluted conditions*
- 473 IEC 60867: *Insulating liquids – Specifications for unused liquids based on synthetic aromatic*  
474 *hydrocarbons*
- 475 IEC 61462: *Composite hollow insulators – Pressurized and unpressurized insulators for use in*  
476 *electrical equipment with rated voltage greater than 1 000 V – Definitions, test methods and*  
477 *acceptance criteria and design recommendations*
- 478 IEC 62271-4: *High-voltage switchgear and controlgear – Use and handling of sulphur*  
479 *hexafluoride (SF<sub>6</sub>) in high-voltage switchgear and controlgear*
- 480 IEC 62155: *Hollow pressurized and unpressurized ceramic and glass insulators for use in*  
481 *electrical equipment with rated voltages greater than 1 000 V*
- 482 IEC 62262: *Degree of protection IK code*
- 483 IEC 62271-207: *High-voltage switchgear and controlgear - Part 207: Seismic qualification for*  
484 *gas-insulated switchgear assemblies for rated voltages above 52 kV.*
- 485 IEC TS 62271-210: *High-voltage switchgear and controlgear - Part 210: Seismic qualification*  
486 *for metal enclosed and solid-insulation enclosed switchgear and controlgear assemblies for*  
487 *rated voltages above 1 kV and up to and including 52 kV.*
- 488 IEC 62271-203: *High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-*  
489 *enclosed switchgear for rated voltages above 52 kV*
- 490 CISPR 18-2: *Radio interference characteristics of overhead power lines and high-voltage*  
491 *equipment – Part 2: Methods of measurement and procedure for determining limits*
- 492 IEC Guide 109: *Environmental aspects – Inclusion in electrotechnical product standards*
- 493 ISO 3231: *Paints and varnishes – Determination of resistance to humid atmospheres*  
494 *containing sulphur dioxide*
- 495

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1 General definitions

##### 3.1.1

##### **instrument transformer**

transformer intended to transmit an information signal to measuring instruments, meters and protective or control devices or similar apparatus

[SOURCE: IEC 321-01-01, modified: add “or similar apparatus”]

##### 3.1.2

##### **Current transformer**

##### **CT**

instrument transformer in which the secondary current, under normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections

[SOURCE: IEC 60050-321:1986, 321-02-01]

##### 3.1.3

##### **Voltage transformer**

##### **VT**

instrument transformer in which the secondary voltage, in normal conditions of use, is substantially proportional to the primary voltage and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections

[SOURCE: IEC 60050-321:1986, 321-03-01]

##### 3.1.4

##### **bushing type current transformers**

current transformer without primary conductor and primary insulation of its own which can be fitted directly over an insulated bushing or conductor

[SOURCE: IEC 321-02-02]

##### 3.1.5

##### **enclosure**

housing affording the type and degree of protection suitable for the intended application

NOTE to entry: This definition needs the following explanations under the scope of this standard:

1. Enclosures provide protection for persons or animals against access to hazardous parts;
2. Enclosures provide protection for equipment against the harmful effects of mechanical impacts;
3. Barriers, shapes of openings or any other means – whether attached to the enclosure or formed by the enclosed equipment – suitable to prevent or limit penetration, are considered as a part of the enclosure, except when they can be removed without the use of a key or tool.

[SOURCE: IEC 151-13-08, modified: Note to entry]

##### 3.1.6

##### **primary terminal**

terminal to which the voltage or current to be transformed is applied

536 **3.1.7**  
537 **secondary terminals**  
538 terminals which transmit an information signal to measuring instruments, meters and  
539 protective or control devices or similar apparatus

540 **3.1.8**  
541 **secondary circuit**  
542 external circuit receiving the information signals supplied by the secondary terminals of an  
543 instrument transformer

544 [SOURCE: IEC 321-01-08, modified: “winding” replaced by “terminals”]

545 **3.1.9**  
546 **section**  
547 electrically conductive part of an instrument transformer insulated from other similar parts and  
548 equipped with terminals

549 EXAMPLE: primary or secondary reconnectable windings, shielding to be externally grounded, temperature  
550 sensors.

551 **3.1.10**  
552 **EMC**  
553 ability of an equipment or system to function satisfactorily in its electromagnetic environment  
554 without introducing intolerable electromagnetic disturbances to anything in that environment

555 [SOURCE: IEC 161-01-07].

## 556 **3.2 Definitions related to voltage and dielectric aspects**

557 **3.2.1**  
558 **highest voltage of a system**  
559  $U_{sys}$   
560 highest value of the line-to-line operating voltage (rms value) which occurs under normal  
561 operating conditions at any time and at any point in the system

562 [SOURCE: IEC 601-01-23, modified: add “line-to-line” and (rms value)]

563 **3.2.2**  
564 **highest voltage for equipment**  
565  $U_m$   
566 highest value of line-to-line voltage (rms value) for which the equipment is designed in  
567 respect of its insulation as well as other characteristics which relate to this voltage in the  
568 relevant equipment standards under normal service condition

569 [SOURCE: IEC 614-03-01]

570 **3.2.3**  
571 **rated primary voltage**  
572  $U_{pr}$   
573 for voltage transformer, value of the primary voltage of the transformer and on which its  
574 performance is based

575 [SOURCE: IEC 321-01-12 modified: add “for voltage transformer”]

576 **3.2.4**  
577 **rated insulation level**  
578 combination of voltage values which characterizes the insulation of a transformer with regard  
579 to its capability to withstand dielectric stresses

**3.2.5****isolated neutral system**

system where the neutral point is not intentionally connected to earth, except for high impedance connections for protection or measurement purposes

[SOURCE: IEC 601-02-24]

**3.2.6****resonant earthed system**

system in which one or more neutral points are connected to earth through reactors which approximately compensate the capacitive component of a single-phase-to-earth fault current

NOTE to entry With resonant earthing of a system, the residual current in the fault is limited to such an extent that an arcing fault in air is self-extinguishing.

[SOURCE: IEC 601-02-27 modified: note to entry]

**3.2.7****earth fault factor**

at a given location of a three-phase system, and for a given system configuration, ratio of the highest rms value of line-to-earth power frequency voltage on a healthy line conductor during an earth fault affecting one or more line conductors at any point on the system, to the rms value of line-to-earth power frequency voltage which would be obtained at the given location in the absence of any such earth fault

[SOURCE: IEC 614-03-06]

**3.2.8****earthed neutral system**

system in which the neutral is connected to earth either solidly or through a resistance or reactance of sufficiently low value to reduce transient oscillations and to give a current sufficient for selective earth fault protection

a) A three-phase system with effectively earthed neutral at a given location is a system characterized by an earth fault factor at this point which does not exceed 1,4.

NOTE to entry This condition is obtained approximately when, for all system configurations, the ratio of zero-sequence reactance to the positive-sequence reactance is less than 3 and the ratio of zero-sequence resistance to positive sequence reactance is less than one.

b) A three-phase system with non-effectively earthed neutral at a given location is a system characterized by an earth fault factor at this point that may exceed 1,4.

**3.2.9****solidly earthed neutral system**

system whose neutral point(s) is(are) earthed directly

[SOURCE: IEC 601-02-25]

**3.2.10****impedance earthed neutral system**

system whose neutral point(s) is(are) earthed through impedances to limit earth fault currents

[SOURCE: IEC 601-02-26]

**3.2.11****exposed installation**

installation in which the apparatus is subject to overvoltage's of atmospheric origin

NOTE to entry Such installations are usually connected to overhead transmission lines either directly or through a short length of cable.

**3.2.12****non-exposed installation**

installation in which the apparatus is not subject to overvoltage's of atmospheric origin

NOTE to entry Such installations are usually connected to underground cable networks.

**3.3 Definitions related to current ratings****3.3.1****rated primary current** $I_{pr}$ 

value of the primary current which appears in the designation of the current transformer and on which the performance of the transformer is based

[SOURCE: IEC 321-01-11]

**3.3.2****rated short-time thermal current** $I_{th}$ 

maximum value of the primary current which a current transformer will withstand for a specified short time without suffering harmful effects, the secondary winding being short-circuited

[SOURCE: IEC 321-02-22]

**3.3.3****rated dynamic current** $I_{dyn}$ 

maximum peak value of the primary current which a current transformer will withstand, without being damaged electrically or mechanically by the resulting electromagnetic forces, the secondary winding being short-circuited

[SOURCE: IEC 321-02-24]

**3.3.4****rated continuous thermal current** $I_{cth}$ 

value of the current which can be permitted to flow continuously in the primary winding, the secondary winding being connected to the rated burden, without the temperature rise exceeding the values specified

[SOURCE: IEC 321-02-25]

**3.3.5****rated primary short-circuit current** $I_{psc}$ 

rms value of the a.c. component of a transient primary short-circuit current on which the accuracy performance of a current transformer is based

Note to entry: While  $I_{th}$  is related to the thermal limit,  $I_{psc}$  is related to the accuracy limit. Usually,  $I_{psc}$  is smaller than  $I_{th}$ .

**3.4 Definitions related to accuracy****3.4.1****actual transformation ratio** $K$ 

ratio of the actual primary voltage or current to the actual secondary voltage or current

**3.4.2****rated transformation ratio** **$K_r$** 

ratio of the rated primary voltage or current to the rated secondary voltage or current

**3.4.3****ratio error** **$\varepsilon$** 

error which an instrument transformer introduces into the measurement and which arises from the fact that the actual transformation ratio is not equal to the rated transformation ratio

Note to entry: The ratio error for current or voltage is defined by the following formula:

$$\varepsilon = \frac{K_r Y_s - X_p}{X_p} \times 100\%$$

where

$K_r$  is the rated transformation ratio;

$X_p$  is the rms value of the actual primary signal (current or voltage) in steady state

$Y_s$  is the rms value of output signal (current or voltage)

This definition is only related to components at rated burden and rated frequency of both primary signal and secondary signal and does not take into account direct signal components.

**3.4.4****phase displacement** **$\Delta\varphi$** 

difference in phase between the primary voltage or current and the secondary voltage or current phasors, the direction of the phasors being so chosen that the angle is zero for an ideal transformer

The phase displacement is said to be positive when the secondary voltage or current phasors leads the primary voltage or current phasors. It is usually expressed in minutes or centiradians.

NOTE to entry This definition is strictly correct for sinusoidal voltages or currents only.

[SOURCE: IEC 321-01-23, modified: add “phasors” and the measurement units]

**3.4.5****Phase error**

error which an instrument transformer introduces into the measurement and which arises from the fact that the actual secondary voltage or current phasor is not in phase with the primary phasor, after consideration of the phase offset due to the sensor technology and the rated delay time related to the signal processing

Note to entry: Conventional Instrument Transformers, covered by IEC 61869-2, IEC 61869-3 and IEC 61869-5, are to be considered as special cases, in which phase displacement is equivalent to phase error

**3.4.6****accuracy class**

designation assigned to an instrument transformer, the ratio error and phase displacement of which remain within specified limits under prescribed conditions of use

[SOURCE: IEC 321-01-24, modified: replace “current” or “voltage” by “ratio”]

711 **3.4.7**  
712 **burden**  
713 admittance (or impedance) of the secondary circuit expressed in Siemens (or ohms) and  
714 power factor

715 NOTE to entry The burden is usually expressed as the apparent power in volt-amperes absorbed in the secondary  
716 circuit at a specified power-factor and at the rated secondary voltage or current.

717 [SOURCE: IEC 321-01-25, modified (add admittance, units and power factor)]

718 **3.4.8**  
719 **rated burden**  
720 value of the burden on which the accuracy requirements of this specification are based

721 [SOURCE: IEC 321-01-26]

722 **3.4.9**  
723 **rated output**  
724  $S_r$   
725 value of the apparent power (in Volt-amperes at a specified power factor) which the  
726 instrument transformer is intended to supply to the secondary circuit at the rated secondary  
727 voltage or current and with rated burden connected to it

728 [SOURCE: IEC 321-01-27 modified: add ("in Volt-amperes...")]

729 **3.4.10 Power factor**  
730 under periodic conditions, ratio of the absolute value of the active power P to the apparent  
731 power S

732 [SOURCE: IEC 131-11-46]

### 733 **3.5 Definitions related to other ratings**

734 **3.5.1**  
735 **rated frequency**  
736  $f_r$   
737 value of the frequency on which the requirements of this standard are based

738 **3.5.2**  
739 **mechanical load**  
740  $F$   
741 forces on different parts of the instrument transformer as a function of four main forces:  
742 – forces on the terminals due to the line connections,  
743 – forces due to the wind,  
744 – seismic forces,  
745 – electro dynamic forces due to short circuit current.

### 746 **3.6 Definitions related to gas insulation**

747 **3.6.1**  
748 **pressure relief device**  
749 device suitable to limit dangerous over-pressures inside the instrument transformer

750 **3.6.2**  
751 **gas-insulated metal-enclosed instrument transformer**  
752 metal-enclosed instrument transformer intended to be mounted on Gas-Insulated Switchgear  
753 (GIS), inside or outside the switchgear enclosure

- 754 **3.6.3**  
755 **closed pressure system**  
756 volume that is replenished only periodically by manual connection to an external gas source
- 757 **3.6.4**  
758 **rated filling pressure**  
759 pressure referred to the standard atmospheric air conditions (20 °C and 101,3 kPa) to which  
760 the gas-insulated instrument transformer is filled before being put in service, or periodically  
761 replenished
- 762 **3.6.5**  
763 **minimum functional pressure**  
764 pressure referred to the standard atmospheric air conditions (20 °C and 101,3 kPa) at which,  
765 and above which, rated insulation and other characteristics of the gas-insulated instrument  
766 transformer are maintained and at which gas replenishment becomes necessary
- 767 **3.6.6**  
768 **absolute leakage rate**  
769 amount of gas escaped by time unit, expressed in Pa.m<sup>3</sup>/s
- 770 **3.6.7**  
771 **relative leakage rate**  
772  $F_{rel}$   
773 absolute leakage rate related to the total amount of gas in the instrument transformer at rated  
774 filling pressure (or density). It is expressed in percentage per year
- 775 **3.6.8**  
776 **permissible leakage rate**  
777  $F_p$   
778 maximum permissible absolute leakage rate of gas specified by the manufacturer for a part, a  
779 component or a sub-assembly, or by using the tightness coordination chart (TC), for an  
780 arrangement of parts, components or subassemblies connected together in one pressure  
781 system
- 782 **3.6.9**  
783 **sniffing**  
784 action of slowly moving a leak meter sensing probe around an assembly to locate a gas leak

### 3.7 Index of abbreviations

|               |                                     |
|---------------|-------------------------------------|
| AIS           | Air-Insulated Switchgear            |
| CT            | Current Transformer                 |
| EMC           | Electro-magnetic compatibility      |
| $F$           | Mechanical load                     |
| $f_r$         | Rated frequency                     |
| $F_{rel}$     | Relative leakage rate               |
| $F_p$         | Permissible leakage rate            |
| GIS           | Gas-Insulated Switchgear            |
| $I_{cth}$     | Rated continuous thermal current    |
| $I_{dyn}$     | Rated dynamic current               |
| $I_{pr}$      | Rated primary current               |
| $I_{psc}$     | Rated primary short-circuit current |
| $I_{th}$      | Rated shrot-time333 thermal current |
| IT            | Instrument Transformer              |
| $K$           | Actual transformation ratio         |
| $K_r$         | Rated transformation ratio          |
| $U_m$         | Highest voltage for equipment       |
| $U_{pr}$      | Rated primary voltage               |
| $U_{sys}$     | Highest voltage of a system         |
| $S_r$         | Rated output                        |
| VT            | Voltage Transformer                 |
| $\varepsilon$ | Ratio error                         |
| $\Delta\phi$  | Phase displacement                  |

## 4 Normal and special service conditions

### 4.1 General

Unless otherwise specified, instrument transformers are intended to be used at their rated characteristics under the normal service conditions listed in 4.2.

If the actual service conditions differ from these normal service conditions, instrument transformers shall be designed to comply with any special service conditions required by the purchaser or appropriate arrangements shall be made (see 4.3).

Detailed information concerning classification for environmental conditions is given in IEC 60721-3-3 (indoor) and IEC 60721-3-4 (outdoor).

For gas-insulated metal-enclosed instrument transformers, Clause 2 of IEC 62271-203 is applicable.

### 4.2 Normal service conditions

#### 4.2.1 Ambient air temperature

Instrument transformers are classified in three categories as given in Table 1.

801

**Table 1 – Temperature categories**

| Category | Minimum temperature<br>°C | Maximum temperature<br>°C |
|----------|---------------------------|---------------------------|
| –5/40    | –5                        | 40                        |
| –25/40   | –25                       | 40                        |
| –40/40   | –40                       | 40                        |

NOTE 1 In the choice of the temperature category, storage and transportation conditions should also be considered.

NOTE 2 In case of instrument transformers integrated within other equipment (e.g. GIS, circuit breaker) the instrument transformer should be specified for the temperature conditions for the respective equipment.

802

803 **4.2.2 Altitude**

804 The altitude does not exceed 1 000 m.

805 **4.2.3 Vibrations or earth tremors**806 Vibrations due to causes external to the instrument transformers or earth tremors are  
807 negligible.808 **4.2.4 Other service conditions for indoor instrument transformers**

809 Other considered service conditions are as follows:

810 a) the influence of solar radiation may be neglected;

811 b) the ambient air is not significantly polluted by dust, smoke, corrosive gases, vapours or  
812 salt;

813 c) the conditions of humidity are as follows:

814 the average value of the relative humidity, measured for a period of 24 h does not exceed  
815 95 %;

816 the average value of the water vapour pressure for a period of 24 h does not exceed 2,2 kPa;

817 the average value of the relative humidity for a period of one month does not exceed 90 %;

818 the average value of the water vapour pressure for a period of one month does not exceed  
819 1,8 kPa.

820 For these conditions, condensation may occasionally occur.

821 NOTE 1 Condensation may be expected where sudden temperature changes occur in periods of high humidity.

822 NOTE 2 To withstand the effects of high humidity and condensation, such as the breakdown of insulation or the  
823 corrosion of metallic parts, instrument transformers designed for such conditions should be used.824 NOTE 3 Condensation may be prevented by special design of the housing, by suitable ventilation and heating, or  
825 using a dehumidifying device.826 **4.2.5 Other service conditions for outdoor instrument transformers**

827 Other considered service conditions are as follows:

828 a) the average value of the ambient air temperature, measured over a period of 24 h, does  
829 not exceed 35 °C;830 b) solar radiation up to a level of 1 000 W/m<sup>2</sup> (on a clear day at noon) shall be considered;831 c) the ambient air may be polluted by dust, smoke, corrosive gases, vapours or salt. The  
832 pollution does not exceed the pollution levels given in IEC 60815;

833 d) the wind pressure does not exceed 700 Pa (corresponding to a 34 m/s wind speed);