

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**High-voltage switchgear and controlgear –
Part 212: Compact Equipment Assembly for Distribution Substation (CEADS)**

**Appareillage à haute tension –
Partie 212: Ensemble Compact d'Équipement pour Postes de Distribution
(ECEPD)**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2016 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

65 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**High-voltage switchgear and controlgear –
Part 212: Compact Equipment Assembly for Distribution Substation (CEADS)**

**Appareillage à haute tension –
Partie 212: Ensemble Compact d'Équipement pour Postes de Distribution
(ECEPD)**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.130.10

ISBN 978-2-8322-3633-8

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 General	10
1.1 Scope	10
1.2 Normative references.....	10
2 Normal and special service conditions	12
2.1 Normal service conditions	12
2.2 Special service conditions.....	12
3 Terms and definitions	12
4 Ratings.....	14
4.1 Rated voltage	14
4.2 Rated insulation level.....	15
4.3 Rated frequency (f_r).....	15
4.4 Rated normal current and temperature rise	15
4.4.1 Rated normal current (I_r, I_{nA}).....	15
4.4.2 Temperature rise	15
4.5 Rated short-time withstand currents (I_k, I_{ke}, I_{CW}).....	16
4.5.101 Rated short-time phase to phase and rated short-time phase to earth withstand currents of high-voltage functional unit and rated short-time withstand current of high-voltage interconnection (I_k, I_{ke})	16
4.5.102 Rated short-time withstand currents of low-voltage functional unit and low-voltage interconnection (I_{CW}).....	16
4.5.103 Short-time withstand currents of high-voltage/low-voltage transformer functional unit.....	16
4.6 Rated peak withstand currents (I_p, I_{pe}, I_{pk})	16
4.6.101 Rated peak phase to phase and rated peak phase to earth withstand currents of high-voltage functional unit and rated peak withstand current of high-voltage interconnection (I_p, I_{pe})	16
4.6.102 Rated peak withstand currents of low-voltage and low-voltage interconnection (I_{pk}).....	17
4.6.103 Peak withstand currents of high-voltage/low-voltage transformer functional unit.....	17
4.7 Rated durations of short circuit (t_k, t_{ke}, t_{CW}).....	17
4.7.101 Rated duration of phase to phase short circuit (t_k) and rated duration of phase to earth short circuit (t_{ke}) of high-voltage functional unit and rated duration of short-circuit of high-voltage interconnection	17
4.7.102 Rated duration of short circuit (t_{CW}) for low-voltage functional unit and low-voltage interconnection	17
4.7.103 Duration of short circuit for high-voltage/low-voltage transformer functional unit.....	17
4.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits	17
4.9 Rated supply frequency of closing and opening devices and of auxiliary circuits.....	17
4.101 Rated power and total losses of CEADS	18
4.102 Ratings of the internal arc classification (IAC).....	18
4.102.1 General	18
4.102.2 Types of accessibility (A, B, AB).....	18
4.102.3 Classified sides	18

4.102.4	Rated arc fault currents (I_A , I_{Ae})	18
4.102.5	Rated arc fault duration (t_A , t_{Ae})	19
5	Design and construction	19
5.1	Requirements for liquids in switchgear and controlgear	19
5.2	Requirements for gases in switchgear and controlgear	20
5.3	Earthing of switchgear and controlgear	20
5.4	Auxiliary and control equipment	20
5.5	Dependent power operation	20
5.6	Stored energy operation.....	21
5.7	Independent manual or power operation (independent unlatched operation)	21
5.8	Operation of releases.....	21
5.9	Low- and high-pressure interlocking and monitoring devices.....	21
5.10	Nameplates.....	21
5.11	Interlocking devices	21
5.12	Position indication.....	21
5.13	Degrees of protection provided by enclosures	21
5.14	Creepage distances for outdoor insulators	22
5.15	Gas and vacuum tightness	22
5.16	Liquid tightness.....	22
5.17	Fire hazard (flammability)	22
5.18	Electromagnetic compatibility (EMC).....	22
5.19	X-ray emission.....	22
5.20	Corrosion.....	23
5.101	Protection against mechanical stresses	23
5.102	Protection of the environment due to internal defects	23
5.103	Internal arc fault.....	23
5.104	Enclosures.....	24
5.105	Sound emission	24
5.106	Electromagnetic fields.....	24
6	Type tests	24
6.1	General.....	24
6.1.1	Grouping of tests	25
6.1.2	Information for identification of test objects.....	25
6.1.3	Information to be included in type-test reports	25
6.2	Dielectric tests	26
6.2.1	General	26
6.2.2	Dielectric tests on the high-voltage interconnection	26
6.2.3	Dielectric tests on the low-voltage interconnection.....	27
6.2.4	Dielectric tests on high-voltage functional unit	28
6.2.5	Dielectric tests on high-voltage/low-voltage transformer functional unit.....	28
6.2.6	Dielectric tests on low-voltage functional unit.....	28
6.2.7	Partial discharge test.....	29
6.3	Radio interference voltage (r.i.v) test	29
6.4	Measurement of the resistance of circuits	29
6.5	Temperature-rise tests	29
6.5.1	General	29
6.5.2	Test conditions	29
6.5.3	Test methods.....	30

6.5.4	Special case of dry-type high-voltage/low-voltage transformer functional unit	33
6.5.5	Measurements	33
6.6	Short-time withstand current and peak withstand current tests	35
6.6.1	Short-time and peak withstand current tests on main circuit of high-voltage and low-voltage functional units	35
6.6.2	Short-time and peak withstand current tests on high-voltage and low-voltage interconnections	35
6.6.3	Short-time and peak withstand current tests on earthing circuits	35
6.6.4	Short-time and peak withstand current tests on high-voltage/low-voltage transformer functional unit	36
6.7	Verification of the protection,	36
6.7.1	Verification of degree of protection (IP coding)	36
6.7.2	Verification of resistance to mechanical impacts (IK coding)	36
6.8	Tightness tests	36
6.9	Electromagnetic compatibility tests (EMC)	36
6.10	Additional tests on auxiliary and control circuits	36
6.10.1	General	36
6.10.2	Functional tests	37
6.10.3	Electrical continuity of earthed metallic parts test	37
6.10.4	Verification of the operational characteristics of auxiliary contacts	37
6.10.5	Environmental tests	37
6.10.6	Dielectric test	37
6.11	X-radiation test procedure for vacuum interrupters	37
6.101	Internal arc test	37
6.101.1	General	37
6.101.2	Test conditions	38
6.101.3	Arrangement of the equipment	38
6.101.4	Test procedure	39
6.101.5	Criteria to pass the test	39
6.101.6	Test report	39
6.101.7	Extension of validity of test results	40
6.102	Verification of making and breaking capacities	40
6.103	Mechanical operation tests	40
6.104	Mechanical stability test	40
6.105	Pressure withstand test for gas-filled compartments	40
6.106	Measurements of leakage currents of non-metallic enclosures	41
6.107	Waterproofing test	41
6.108	Tightness and mechanical strength for liquid filled compartments	41
6.109	Measurement or calculation of electromagnetic fields	41
7	Insulation tests	42
7.1	Dielectric tests on the main circuit	42
7.1.1	General	42
7.1.2	Dielectric tests on high-voltage functional unit	42
7.1.3	Dielectric tests on high-voltage/low-voltage transformer functional unit and high-voltage interconnection	43
7.1.4	Dielectric tests on low-voltage functional unit and low-voltage interconnection	43
7.2	Tests on auxiliary and control circuits	43
7.3	Measurement of the resistance of the main circuit	43

7.4	Tightness test	43
7.5	Design and visual checks	43
7.101	Mechanical operation tests on high-voltage functional unit	43
7.102	Pressure tests of gas-filled compartments	43
7.103	Tests of auxiliary electrical, pneumatic and hydraulic devices	44
7.104	Measurement of the resistance of the windings	44
7.105	Measurement of the voltage ratio	44
7.106	Measurement of the short circuit impedance and load losses	44
7.107	Measurement of no-load losses and current	44
7.108	Inspection of the low-voltage functional unit, including inspection of wiring and, if necessary, electrical operation test	44
7.109	Checking of protective measures and of the electrical continuity of the protective circuits of the low-voltage functional unit	44
7.110	Tests after assembly on site	44
8	Guide to the selection of CEADS	44
8.1	Selection of rated values	45
8.2	Continuous or temporary overload due to changed service conditions	45
8.101	Selection of internal arc classification	45
8.102	Information	47
9	Information to be given with enquiries, tenders and orders	51
9.1	Information with enquiries and orders	51
9.2	Information with tenders	52
10	Rules for transport, installation, operation and maintenance	52
10.1	Conditions during transport, storage and installation	53
10.2	Installation	53
10.2.1	Unpacking and lifting	53
10.2.2	Assembly	53
10.2.3	Mounting	53
10.2.4	Final installation inspection	53
10.3	Operation	53
10.4	Maintenance	54
10.5	Dismantling, recycling and disposal at the end of service life	54
11	Safety	54
11.101	Electric aspects	54
11.102	Mechanical aspects	54
11.103	Thermal aspects	54
11.104	Internal arc aspects	54
12	Influence of the product on the environment	54
Annex A	(normative) Method for testing CEADS under conditions of arcing due to an internal arc fault	56
AA.1	General	56
AA.2	Room simulation	56
AA.3	Indicators (for assessing the thermal effects of the gases)	56
AA.3.1	General	56
AA.3.2	Arrangement of indicators	57
AA.4	Tolerances for geometrical dimensions of test arrangements	58
AA.5	Test parameters	58
AA.6	Test procedure	58
AA.7	Designation of the internal arc classification	59

Annex BB (normative) Test to verify the sound level of a CEADS.....	68
BB.1 Purpose	68
BB.2 Test object.....	68
BB.3 Test method.....	68
BB.4 Measurements	68
BB.5 Presentation and calculation of the results	68
Annex CC (informative) Types and application of CEADS	69
CC.1 Type of CEADS.....	69
CC.1.1 General	69
CC.1.2 CEADS-G	69
CC.1.3 CEADS-A	69
CC.1.4 CEADS-I.....	69
CC.2 Application of CEADS	69
Bibliography.....	73
Figure 1 – Test diagram in case of type tested high-voltage functional unit.....	31
Figure 2 – Test diagram in case of non-type tested high-voltage functional unit.....	31
Figure 3 – Alternative diagram in case of type tested high-voltage functional unit.....	32
Figure 4 – Diagram for the open-circuit test	33
Figure AA.1 – Mounting frame for vertical indicators	60
Figure AA.2 – Horizontal indicators.....	60
Figure AA.3 – Protection of operators in front of classified side(s) of CEADS.....	61
Figure AA.4 – Protection of general public around the CEADS.....	61
Figure AA.5 – Protection of operators in front of classified side(s) of CEADS having a pressure relief volume below the floor.....	62
Figure AA.6 – Protection of general public around the CEADS having a pressure relief volume below the floor	63
Figure AA.7 – Selection of tests on high-voltage switchgear for class IAC-A	64
Figure AA.8 – Selection of tests on high-voltage switchgear for class IAC-B	65
Figure AA.9 – Selection of tests on high-voltage interconnection for class IAC-A	66
Figure AA.10 – Selection of tests on high-voltage interconnection for class IAC-B	67
Figure CC.1 – Application of CEADS	70
Figure CC.2 – CEADS Type G	71
Figure CC.3 – CEADS Type A.....	71
Figure CC.4 – CEADS Type I.....	72
Table 1 – Locations, causes and examples of measures decreasing the probability of internal arc faults.....	45
Table 2 – Examples of measures limiting the consequences of internal arc faults	46
Table 3 – Summary of technical requirements, ratings for CEADS – Service conditions	47
Table 4 – Summary of technical requirements, ratings for CEADS – Ratings of the CEADS	48
Table 5 – Summary of technical requirements, ratings for CEADS – Design and construction of the CEADS	50

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 212: Compact Equipment Assembly
for Distribution Substation (CEADS)

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, accept 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) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62271-212 has been prepared by subcommittee 17C: Assemblies, of IEC technical committee 17: High-voltage switchgear and controlgear.

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

FDIS	Report on voting
17C/645/FDIS	17C/650/RVD

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

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

This International Standard should be read in conjunction with IEC 62271-1:2007, to which it refers and which is applicable unless otherwise specified. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-1. Amendments to these clauses and subclauses are given under the same numbering, whilst additional subclauses, are numbered from 101.

A list of all parts of the IEC 62271 series can be found, under the general title *High-voltage switchgear and controlgear*, on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of the publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Traditionally a high-voltage/low-voltage distribution substation has been constructed by installing the main electrical components –high-voltage switchgear, distribution transformer(s) and the corresponding low-voltage distribution panel(s)- within a closed electrical operating area. It can be a room within a building intended for other (non electrical uses) or a separated housing (prefabricated or not) designed specifically to contain the electrical equipment of the substation or an open area limited by fences.

Some years ago in the search for a more standardized and compact substation, the concept of prefabricated substation was developed. IEC 62271-202 covers this type of substation. According to this document, the main electrical components (high-voltage switchgear, transformer and low-voltage switchgear) are fully in compliance with their respective product standard, and the whole substation, including interconnections and enclosure is designed and type tested and later manufactured and routine tested in the factory. Correspondingly the quality of the substation is assured by the manufacturer.

Moreover, also other types of assemblies have been introduced in the market. These are assemblies comprising the main electrical active components of the substation and their interconnections, delivered as a single product. The product can therefore be type tested, manufactured, routine tested in the factory, transported and then installed in a closed electrical operating area.

This type of factory assembled and type-tested product is covered by this document receiving the generic name CEADS from Compact Equipment Assembly for Distribution Substation. Numerous arrangements are possible and this document provides guidance on basic types of assemblies, which might be envisaged.

A CEADS is not covered by IEC 61936-1. However CEADS is intended to become part of a distribution substation.

Taking into account the closer proximity of the components that even can share some parts (enclosure, solid or fluid insulation...) it is very relevant to pay attention to the potential interaction between them. Therefore to cover CEADS is neither sufficient nor always applicable to refer to the relevant product standards. This document covers any additional design and construction requirements and test methods applicable to the different types of CEADS. In addition to the specified characteristics, particular attention has been paid to the specification concerning the protection of persons, both operators and general public.

The CEADS is also for the interest of committee TC 14: Power transformers, and committee TC 121: Switchgear and controlgear and their assemblies for low voltage.