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Sestav kompaktne opreme za razdeljevalne (distribucijske) postaje

Compact Equipment Assembly for Distribution Substations (CEADS)

Hochspannungs-Schaltgeräte und -Schaltanlagen - Kompakte
Schaltgerätekombinationen für Verteilungsstationen

Ensembles Compacts d'Équipement pour Postes de Distribution (ECEPD)

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Compact Equipment Assembly for Distribution Substations (CEADS)

Ensembles Compacts d'Équipement
pour Postes de Distribution (ECEPD)

Kompakte Gerätekombination
für Verteilungsstationen (CEADS)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 17AC, High-voltage switchgear and controlgear. It was submitted to the formal vote and approved by CENELEC on 2010-04-01.

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The following dates were fixed:

- latest date by which the EN has to be implemented
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Introduction

The objective of this standard is to respond to the currently in use compact assemblies that perform the main electrical functions of a distribution substation. Numerous arrangements are possible and this standard provides guidance on basic types of assemblies, which might be envisaged (see Annex C).

As there are potential interactions between devices within such assemblies, it is necessary to consider the standardisation requirements for the assembly in its entirety.

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1 General

1.1 Scope

This European Standard specifies the service conditions, rated characteristics, general structural requirements and test methods of the prefabricated assembly of the main electrical functional units of a HV/LV Distribution Substation, duly interconnected, for alternating current of rated operating voltages above 1 kV and up to and including 52 kV on the HV side, service frequency 50 Hz. This assembly is to be cable-connected to the network.

This Compact Equipment Assembly for Distribution Substation (CEADS) as defined in this standard is designed and tested to be a single product with a single serial number and one set of documentation. Such equipment is delivered as single transport unit. For practical reasons manufacturer and user can agree to transport the unit dismantled if transport or installation of the complete CEADS is not possible. In that case suitable verification tests shall be carried out at the installation site.

Note 1: Where the functional units are independent each functional unit will also have its own serial number.

A CEADS is not a Distribution Substation, either prefabricated (covered by EN 62271-202) or not (covered by EN 61936-1). However CEADS is intended to become part of a Distribution Substation assembling the HV equipment, the power transformer and the LV equipment duly interconnected (see Annex C, which also explains the origin and types of CEADS).

The functions of a CEADS are:

- switching and control for the operation of the HV side and protection of the HV/LV transformer functional unit;
- HV/LV transformation;
- switching and control for the operation and protection of the LV feeders.

However relevant provisions of this standard are also applicable to designs where not all of these functions exist (e.g. equipment comprising only HV/LV transformation and switching and control for the operation and protection of the LV feeder functions).

For public distribution networks, CEADS are intended for installation within an indoor or outdoor closed electrical operating area (see Definition 1.3.3) forming part of a Distribution Substation.

For industrial applications, such as factories, installation of CEADS outside a closed electrical operating area may be allowed provided that safety regulations are fulfilled by additional measures adopted at the installation site under the responsibility of the designer of the installation.

This standard considers the potential interaction between the individual functions when closely installed and interconnected to form a type tested assembly and defines ratings, particular design and construction requirements and test procedures for this assembly.

NOTE 2 Interaction is the influence of one functional units of the equipment on another (i.e. electrical mechanical and thermal stresses).

NOTE 3 For the purpose of this standard a self-protected transformer is considered not as a CEADS, but as a functional unit, designed and type tested to its own product standard EN 60076-13.

1.2 Normative references

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

EN 50464 series, *Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2 500 kVA with highest voltage for equipment not exceeding 36 kV*

EN 50464-1:2007, *Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2 500 kVA with highest voltage for equipment not exceeding 36 kV – Part 1: General requirements*

EN 50464-4:2007, *Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2 500 kVA with highest voltage for equipment not exceeding 36 kV – Part 4: Requirements and tests concerning pressurised corrugated tanks*

EN 60076 series, *Power transformers* (IEC 60076 series)

EN 60076-1:1997 + A11:1997 + A1:2000 + A12:2002, *Power transformers – Part 1: General* (IEC 60076-1:1993, mod. + A1:1999)

EN 60076-2:1997, *Power transformers – Part 2: Temperature rise* (IEC 60076-2:1993, mod.)

EN 60076-3:2001, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air* (IEC 60076-5:2000 + corr. Dec. 2000)

EN 60076-5: 2006, *Power transformers – Part 5: Ability to withstand short circuit* (IEC 60076-5: 2006)

EN 60076-10, *Power transformers – Part 10: Determination of sound levels* (IEC 60076-10)

EN 60076-11:2004, *Power transformers – Part 11: Dry-type transformers* (IEC 60076-11:2004)

EN 60076-13:2007, *Power transformers – Part 13: Self-protected liquid-filled transformers* (IEC 60076-13:2006)

EN 60243-1, *Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies* (IEC 60243-1)

EN 60439 series, *Low-voltage switchgear and controlgear assemblies* (IEC 60439 series)

EN 60439-1:1999, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies* (IEC 60439-1:1999)

EN 60529, *Degrees of protection provided by enclosures (IP Code)* (IEC 60529:1989)

EN 60664-1:2003, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests* (IEC 60664-1:1992 + A1:2000 + A2:2002)

EN 60721-1, *Classification of environmental conditions – Part 1: Environmental parameters and their severities* (IEC 60721-1)

EN 60947-1, *Low-voltage switchgear and controlgear – Part 1: General rules* (IEC 60947-1)

EN 61439 series ¹⁾, *Low-voltage switchgear and controlgear assemblies* (IEC 61439 series)

EN 61936-1, *Power installations exceeding 1 kV a.c. – Part 1: Common rules* (IEC 61936-1 ²⁾)

EN 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)* (IEC 62262)

¹⁾ This series will supersede some parts of EN 60439 series.

EN 62271-1:2008, *High-voltage switchgear and controlgear – Part 1: Common specifications* (IEC 62271-1:2007)

EN 62271-200:2004, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV* (IEC 62271-200:2003)

EN 62271-201:2006, *High-voltage switchgear and controlgear – Part 201: AC insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV* (IEC 62271-201:2006)

EN 62271-202, *High-voltage switchgear and controlgear – Part 202: High voltage/low voltage prefabricated substation* (IEC 62271-202)

HD 60364-4-41, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock* (IEC 60364-4-41)

IEC 60050-441, *International Electrotechnical Vocabulary – Switchgear, controlgear and fuses*

IEC 60721-2-2, *Classification of environmental conditions – Part 2: Environmental conditions appearing in nature. Precipitation and wind*

IEC 60721-2-4, *Classification of environmental conditions – Part 2-4: Environmental conditions appearing in nature – Solar radiation and temperature*

IEC/TS 60815 series, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions*

IEC/TR 62271-300, *High-voltage switchgear and controlgear – Part 300: Seismic qualification of alternating current circuit-breakers*

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1.3 Terms and definitions

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For the purposes of this document the terms and definitions given in IEC 60050-441, EN 62271-1:2008 and in the standards mentioned in 1.2, and the following apply.

1.3.1

Compact Equipment Assembly for Distribution Substation (CEADS)

prefabricated and type-tested assembly comprising functional units, described in 1.1, duly interconnected (see Annex C for details)

1.3.1.1

grouped type CEADS (CEADS-G)

CEADS which functional units are stand alone equipment fully complying with their respective product standards. These equipment is placed close to each other in a specified layout

1.3.1.2

associated type CEADS (CEADS-A)

CEADS which functional units may deviate from existing product standard but not in any aspect that could affect negatively safety and/or operation. They can either be independent units or share part of their frames or enclosures

1.3.1.3

integrated type CEADS (CEADS-I)

CEADS where all or part of HV functional units and the HV/LV transformation functional unit are contained in a single enclosure, sharing the insulating medium

1.3.2**functional unit**

assembly of devices and components performing a given main function of the CEADS

NOTE For the purpose of this standard functional unit has a different meaning than the meaning in other standards. For example in this standard HV functional unit (see the definition below) may comprise several functional units as per EN 62271-200:2004.

1.3.2.1**HV functional unit**

assembly of the switching devices and other components performing the function of switching and control for the operation of the HV side of the CEADS. It may include switching and control of the HV main ring of the network and the protection of the HV/LV transformation function

1.3.2.2**HV/LV transformer functional unit**

assembly of elements that perform the function of HV/LV transformation of the CEADS

1.3.2.3**LV functional unit**

assembly of the switching devices and other components performing the function of switching and control for the operation and protection of the LV feeders of the CEADS

1.3.3**closed electrical operating area**

room or location for operation of electrical installations and equipment to which access is intended to be restricted to skilled or instructed persons or to lay personnel under the supervision of skilled or instructed persons, e.g. by opening of a door or removal of protective barrier only by the use of a key or tool, and which is clearly marked by appropriate warning sign (see 3.2.1 of EN 61936-1)

1.3.4**internal arc classified CEADS (IAC/HV)**

CEADS which meet prescribed criteria, demonstrated by type tests, for the protection of persons in the event of internal arc at the HV side

2 Normal and special service conditions

Clause 2 of EN 62271-1:2008 is applicable with the following addition:

2.1 Normal service conditions

Wave shape and symmetry of supply voltage will be in accordance with 1.2.1 of EN 60076-1:1997.

For HV/LV transformer functional unit, average ambient air temperature limits of 4.3.1 of EN 60076-2:1997 for oil immersed type and 4.2.3 of EN 60076-11:2004 shall also apply.

For indoor CEADS

- the minimum air ambient temperature is -5 °C or -15 °C;
- equipment shall also be suitable for conditions of humidity in accordance with clause 6.1.2.1 of EN 60439-1:1999.

For outdoor CEADS

- the preferred values of minimum air ambient temperature are -10 °C, -25 °C.

NOTE For air ambient below -25 °C, CEADS shall be designed or used according to the relevant product standards, where applicable, or according to agreement between manufacturer and user.

2.2 Special service conditions

Refer to the relevant standards for the different functional units.

3 Requirements for the individual functional units

The complete assembly of a CEADS and the individual functional units forming part of it shall comply with the requirements of this standard. For the individual functional units reference is made to the following respective standards:

- HV functional unit..... EN 62271-200:2004 or EN 62271-201:2006;
- HV/LV transformer functional unit..... EN 60076 series;
- LV functional unit EN 60439 series.

In a CEADS-G the individual functional units shall comply with the requirements of their respective product standard listed above.

Concerning CEADS-A and CEADS-I, the individual functional units may deviate in some aspects from those products standards. Due to that, specific testing procedures for individual functional units, where direct application of above mentioned product standards is not possible, are described in this standard.

4 Ratings

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The ratings of a CEADS comprise the following:

- a) rated operating high voltage;
- b) rated operating low voltage;
- c) rated insulation level for high voltage;
- d) rated insulation level for low voltage;
- e) rated frequency;
- f) rated normal current on high voltage side;
- g) rated normal current of low voltage circuits;
- h) rated short-time withstand current, peak withstand current and duration of short circuit for main HV circuit;
- i) rated short-time withstand current, peak withstand current and duration of short circuit for main LV circuit;
- j) rated short-time withstand current , peak withstand current and duration of short circuit for main earthing circuit;
- k) rated power and total losses;
- l) rated supply voltage of closing and opening devices and auxiliary and control circuits (if any);
- m) rated supply frequency of closing and opening devices and auxiliary and control circuits (if any).

The ratings of CEADS shall be assigned to ensure that operation of the equipment within its assigned ratings does not expose any individual functional unit to conditions which are outside its rated capabilities.

NOTE Functional units forming part of the CEADS may have other individual rated values in accordance with their relevant standards.

4.1 Rated operating voltages

Subclause 3.4.3 of EN 60076-1:1997 is applicable.

NOTE These values are determined by the characteristics of the HV/LV transformer functional unit. HV and LV functional units can have higher rated voltages.

4.2 Rated insulation levels

Table 2 of 7.2 of EN 60076-3:2001 is applicable.

NOTE These values are determined by the characteristics of the HV/LV transformer functional unit. HV and LV functional units can have higher rated insulating levels.

4.3 Rated frequency

The rated frequency of CEADS is 50 Hz.

4.4 Rated normal currents

Subclauses 4.4.1 of EN 62271-1:2008 for HV functional unit and 4.2 of EN 60439-1:1999 for LV functional unit are applicable.

4.5 Rated short-time withstand currents

Subclauses 4.5 of EN 62271-1:2008 for HV functional unit and 4.3 of EN 60439-1:1999 for LV functional unit are applicable.

The rated short-time withstand current assigned to the earthing circuit may differ from that of the main circuit.

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4.6 Rated peak withstand currents

Subclauses 4.6 of EN 62271-1:2008 for HV functional unit and 4.4 of EN 60439-1:1999 for LV functional unit are applicable.

The rated peak withstand current assigned to the earthing circuit may differ from that of the main circuit.

4.7 Rated durations of short circuit

Subclauses 4.7 of EN 62271-1:2008 for HV functional unit, 4.1.3 of EN 60076-5:2006 for the HV/LV transformer functional unit and 4.3 of EN 60439-1:1999 for LV functional unit are applicable.

The rated duration of short circuit assigned to the earthing circuit may differ from that of the main circuit.

4.8 Rated supply voltages of closing and opening devices and of auxiliary and control circuits

Subclauses 4.8 of EN 62271-1:2008 for HV functional unit and 4.1.1 of EN 60439-1:1999 for LV functional unit are applicable.

4.9 Rated supply frequency of closing and opening devices and of auxiliary circuits

Subclauses 4.9 of EN 62271-1:2008 for HV functional unit and 4.8 of EN 60439-1:1999 for LV functional unit are applicable.

4.10 Rated power of CEADS

The rated power of CEADS is given by the rated power and the total losses of the HV/LV transformer functional unit at rated operating voltages and rated normal currents for which the CEADS has been designed.

5 Design and construction

CEADS shall be designed so that normal service, inspection and maintenance can be carried out safely. As CEADS are intended for installation within closed electrical operating areas, in principle general public is not allowed to approach the equipment. However when a CEADS is installed in a factory the workers not in charge of the operation of the equipment may be occasionally in the proximity of the CEADS. As they are not aware of the electrical features of the equipment they are considered as public in the sense of this standard.

NOTE If some parts of enclosures of a CEADS are intended to become part of the enclosure of a substation the relevant requirements of EN 62271-202 or EN 61936-1, as applicable, shall be met.

The design of CEADS shall take into account the possible interactions (e.g. electrical, mechanical and thermal) in the performance of different functional units and the components used to interconnect these.

The design and construction of the individual functional units of CEADS-G shall comply with the requirements of their respective product standards as specified in clause 3. For CEADS-A and CEADS-I the individual product standards shall apply except where direct application is not possible.

5.1 Earthing

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A main earthing conductor system shall be provided to connect to the earth all metallic parts of the CEADS not belonging to the main and/or secondary/auxiliary circuits of the equipment. It consists of a main earthing conductor to which each component is connected through a single circuit.

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If the CEADS has a metallic frame, then it may serve as, or form part of, the main earthing conductor. The fastening system, if any, used to join parts of the frame shall demonstrate to pass the current carrying capability test. The main earthing conductor system shall be designed to withstand the rated short-time and peak withstand current under the neutral earthing condition of the system.

The cross-section of the earthing conductor shall be not less than 30 mm². It shall be terminated by an adequate terminal intended for connection to the earth system of the installation. If the earthing conductor is not made of copper, equivalent thermal and mechanical requirements shall be met.

The continuity of the earth system shall be ensured and corresponding measures preventing corrosion, loosening of bolts etc. shall be taken, taking into account the thermal and mechanical stresses caused by the current it may have to carry.

NOTE The users may establish procedures to check the integrity of all parts of the earthing system (internal and external) either periodically or after a short-circuit current has flown into the earthing system.

Components to be connected to the main earthing conductor system shall include

- the enclosure, if metallic, of the HV functional units from the terminal provided for that purpose;
- the tank of liquid filled HV/LV transformer functional unit or the metallic non active parts of dry-type HV/LV transformer functional unit;
- the frame and/or enclosure, if metallic, of the LV functional unit;
- the earthing connection of automatic controls and remote-control devices;
- the metal shields and the earthing conductors of the HV cables;