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Compact Equipment Assembly for Distribution Substations (CEADS)

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National foreword

This British Standard is the UK implementation of EN 50532:2010.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Compact Equipment Assembly for Distribution Substations (CEADS)

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

Kompakte Gerätekombination für Verteilungsstationen (CEADS)

This European Standard was approved by CENELEC on 2010-04-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

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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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-04-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-04-01

Contents

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Figures

Tableaux

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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.

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.

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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*

1.3 Terms and definitions

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.

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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

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.

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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.

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.

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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

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.

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;

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– the metallic frame of the CEADS, if any;

– earthing switches, if any.

5.2 Auxiliary equipment

For the low-voltage installation embedded in the CEADS (for example, illumination, auxiliary supply, etc.), refer to HD 60364-4-41 or EN 60439-1:1999, as appropriate.

5.3 Nameplate

Each CEADS shall be provided with a durable, clearly legible nameplate, visible in normal service condition, which shall contain at least the following information:

– manufacturer's name or trade mark;

– type designation;

– serial number;

– number of this standard;

– year of manufacture;

– ratings of CEADS listed in Clause 4;

– internal arc designation, where applicable.

The ratings of the functional units shall be listed on separate nameplates, clearly visible, or on the CEADS nameplate. Where functional units are independent they shall be provided with separate nameplates. Each nameplate shall have a unique serial number.

5.4 Degree of protection and internal fault

5.4.1 Degree of protection

Degrees of protection in accordance with EN 60529 shall be as specified below.

The enclosures of HV and LV functional units shall provide at least the degree of protection IP2X for indoor application.

For outdoor application the minimum degree of protection shall be IP23.

If non insulated conductors and/or bushings in LV interconnections or non screened conductors and/or bushings in HV interconnections are used, suitable means to prevent direct contact with live parts shall be provided either by the manufacturer as part of the CEADS itself or alternatively by the user incorporating adequate protection in the installation site. In the first case the minimum degree of protection should be IP1X. In the second case the manufacturer shall include in the instruction manual clear information about the need to provide additional protection.

When dry type transformer is used, a protection means around the transformer shall be provided with at least a degree of protection IP1X.

5.4.2 Protection against mechanical stresses

The enclosures of HV and LV functional units shall withstand external mechanical impacts with energy of 2 J, corresponding to a degree of protection IK07 for indoor application and 20 J corresponding to IK10 for outdoor application.

CEADS intended for outdoor use shall withstand the following additional loads:

– snow loads according to the local climatic conditions;

– wind loads according to 2.1.2 of EN 62271-1:2008.

5.4.3 Protection of the environment due to internal defects

In the event that internal defects may lead to the escape of hazardous liquids from the equipment (for example: oil from a transformer or switchgear), provision shall be made to retain the hazardous liquids in order to prevent the soil being polluted.

The capacity of the retention tank shall be at least equal to the biggest hazardous liquid containing part (for example, transformer, switchgear, etc), unless applicable national regulations have different requirements.

Additional measures may be taken by agreement between manufacturer and user. Those provisions may be a part of the CEADS or provided in the installation site where the CEADS is to be installed.

5.4.4 Internal arc fault

A CEADS that satisfies the requirements of this standard is designed, in principle, to prevent the occurrence of internal arc faults in the HV side.

To achieve this objective the manufacturer of the CEADS shall ensure the correct manufacture, verifying it by carrying out routine tests according to Clause 7. In turn, the user shall make a proper selection, according to the characteristics of the network, operating procedures and service conditions (refer to Clause 8).

There should be little probability that an internal arc occurs during the entire service life, provided that the CEADS is installed, operated and maintained following the instructions provided by the manufacturer and the cables are correctly in-stalled; however, the possibility of an internal arc cannot be completely disregarded.

Failure due either to a defect or an exceptional service condition or mal-operation may initiate an internal arc within the HV functional unit and/or in the HV interconnection, which constitutes a hazard if persons are present.

Failures can occur in any part of the CEADS. However, as no internal arc testing procedure for LV switchgear and transformers is described in their respective relevant standards, only faults occurring within the enclosure of the HV functional units and in the HV interconnection are taken into consideration in this standard (see 6.8).

Evidence of the effectiveness of the design for providing protection of persons in case of an internal arc fault may be required. This evidence shall be obtained by testing the CEADS according to Annex A. CEADS that have been successfully tested qualify as internal arc class IAC/HV.

5.5 Enclosures

The enclosures of the functional units shall comply with the relevant requirements of their respective product standards. In the case that an enclosure is shared by several functional units, it shall comply with the requirements of the products standards of those functional units (example: the tank of the HV/LV transformer functional unit of a CEADS-I shall comply with the requirements of EN 50464 series, if applicable, and EN 62271-200:2004).

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5.6 Sound emission

The HV/LV transformer functional unit is the main source of sound. On the other hand there is no requirement in HV and LV switchgear and controlgear relevant standards on this matter and the direct contribution of the HV and LV functional units to the sound level of the CEADS is considered, in principle, negligible. However the determination of CEADS sound level is to be made according to EN 60076-10, on the complete CEADS to take into account any possible interaction (see Annex B).

5.7 Electromagnetic compatibility (EMC)

Subclauses 5.18 of EN 62271-1:2008 for high-voltage switchgear and controlgear and 7.10 of EN 60439-1:1999 for low-voltage switchgear and controlgear are respectively applicable to the HV and LV functional units of the CEADS.

6 Type test

6.1 General

Subclause 6.1 of EN 62271-1:2008 is applicable with the following additions.

In principle, the type tests shall be made on a representative configuration of the CEADS. The functional units and the interconnections contained in a CEADS shall be tested according to their relevant standard.

Type tests shall be made on the complete CEADS, unless otherwise specified in the standard.

Due to the design of the equipment it may be practical to test more than one function at the same time. In that case it is not required to repeat those tests in which the test conditions applied are the same specified in their respective standards.

The aim of the type tests on a CEADS is to demonstrate the characteristics of the CEADS as a complete unit. The required tests on the complete CEADS, in addition to those required for the individual functional units, are listed below

Mandatory type tests:		**Subclause**
a)	Tests to verify the insulation level of the CEADS	6.2
b)	Test to prove the temperature rise of any part of the equipment	6.3
c)	Measurement of the resistance of the main circuit of the HV functional unit	6.4
d)	Tests to prove the capability of the main and earthing circuits to be subjected to the rated peak and the rated short-time withstand currents	6.5
e)	Functional tests to prove satisfactory operation of the assembly	6.6
f)	Tests to verify the degree of protection and resistance to mechanical impact	6.7
g)	Additional tests on auxiliary and control circuits	6.10
h)	Verification of making and breaking capacities	6.101
i)	Mechanical operation tests	6.102
Mandatory type tests, where applicable:		
j)	Electromagnetic compatibility tests	6.9
k)	For CEADS intended to be classified IAC/HV, tests to assess the effects of arcing due to an internal fault	Annex A

l)	Pressure withstand tests for gas-filled compartments	6.103
m)	Measurements of leakage current of non-metallic enclosures	6.104
n)	Tightness and mechanical strength for liquid-filled compartments	6.201

Special type tests (subject to agreement between manufacturer and user):

o)	Tests to verify the sound level of CEADS	Annex B
p)	Partial discharge test	6.2.6
q)	Weatherproofing tests	6.105

Type tests may impair the suitability of the tested parts for subsequent use in service. Therefore, specimens used for type test shall not be used in service without agreement between manufacturer and user.

6.1.1 Grouping of tests

Subclause 6.1.1 of EN 62271-1:2008 is applicable with the following addition:

The mandatory type tests (not including items j) and k) shall be carried out on a maximum of four specimens.

6.1.2 Information for identification of specimens

Subclause 6.1.2 of EN 62271-1:2008 is applicable.

6.1.3 Information to be included in type-test reports

Subclause 6.1.3 of EN 62271-1:2008 is applicable with the following addition to the list:

- the identification, including serial numbers as appropriate, of all functional units of the CEADS, together with the identification of the CEADS itself;
- details of the mechanical and electrical interconnections of the functional units as part of the CEADS;
- drawings and photographs to demonstrate that physical arrangement of the equipment during testing.

6.2 Dielectric tests

When performing dielectric tests, three situations can be considered. In order to limit the number of required tests, following criteria are applicable:

a) in the case that each of the main components of the CEADS (HV, HV/LV transformer and LV functional units) have been type-tested according to their relevant standards, and the Interconnections have been previously tested under the same conditions as in the CEADS there is no need to conduct dielectric tests;

b) in case the main components (HV, HV/LV transformer, LV functional units) are type tested, but the interconnections are not previously tested, the tests as stated in 6.2.1 and 6.2.2 shall be carried out;

c) in all other cases, dielectric tests as stated in 6.2.1, 6.2.2, 6.2.3, 6.2.4 and 6.2.5 shall be carried out.

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6.2.1 Dielectric tests on the high voltage interconnection

6.2.1.1 General conditions

The tests may be carried out with the transformer replaced by a mock-up reproducing the field configuration of the transformer bushings.

For the tests, the high-voltage connection is connected to the test supply through the HV functional unit. Only the switching devices that are in series in the supply circuit are closed. All other switching devices are open.

Voltage limiting devices shall be disconnected during dielectric tests.

Secondary terminals of current transformers shall be short-circuited and connected to earth.

Voltage transformers shall be disconnected.

6.2.1.2 Ambient air conditions during tests

Refer to 6.2.1 of EN 62271-1:2008.

6.2.1.3 Application of test voltage

6.2.1.3.1 On the high-voltage interconnection

The test voltages shall be applied connecting each phase conductor of the main circuit in turn to the high-voltage terminal of the test supply. All other conductors of the main circuit, the auxiliary circuits and all other metallic parts shall be connected to the earthing conductor of the frame, and to the earth terminal of the test supply. Where no-earth-shielded high-voltage connections are used the non conductive material shall likewise withstand the test voltages specified in 6.2.1.6. The methods specified in EN 60243-1 should be applied to the test to meet the relevant requirements.

6.2.1.3.2 Test voltage

Refer to 6.2.6 of EN 62271-1:2008.

6.2.1.4 Lightning impulse-voltage tests

The high-voltage interconnection shall be subjected to lightning impulse-voltage tests according to EN 62271-1:2008 with the following addition:

During the lightning impulse-voltage tests, the grounded terminal of the impulse generator shall be connected to the main earthing conductor system of the CEADS.

6.2.1.5 Power-frequency voltage withstand tests

The high-voltage interconnection shall be subjected to 1 min power-frequency voltage withstand tests in dry conditions in accordance with EN 62271-1:2008 with the following addition:

During the power-frequency voltage test, one terminal of the test transformer shall be connected to earth and to the main earthing conductor system of the CEADS.

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6.2.1.6 HV interconnection covered by non-metallic enclosure

When the interconnection is totally or partially covered by a non-metallic enclosure accessible during normal operation, the enclosure shall meet the following requirements.

a) The insulation between live parts of the main circuit and the accessible surface of insulating enclosure shall withstand the test voltages specified in 4.2 of EN 62271-1:2008 for voltage tests to earth and between poles.

b) The insulating material shall withstand the power-frequency test voltage specified in item a). The appropriate test methods given in EN 60243-1 should be applied.

c) The insulation between live parts of the main circuit and the inner surface of insulating enclosure facing these shall withstand at least 150 % of the rated voltage of the equipment.

d) If a leakage current may reach the accessible side of the insulating enclosure by a continuous path over insulating surfaces, it shall be not greater than 0,5 mA under the specified test conditions (refer to 6.104).

6.2.2 Dielectric tests on the low voltage interconnection

6.2.2.1 General conditions

When the low-voltage interconnection is partially or totally covered by a non-metallic enclosure, the enclosure shall be covered by a circular or square metal foil having an area as large as possible, but not exceeding 100 cm² connected to the earth. The foil shall be applied to all surfaces that can be touched by an operator.

For the tests, the low-voltage interconnection is connected to the test supply through the LV functional unit. Only the switching devices that are in series in the supply circuit are closed. All other switching devices are open.

6.2.2.2 Lightning impulse-voltage tests

The low-voltage interconnection shall be subjected to lightning impulse-voltage tests. The test voltage is specified in Table 5 of EN 60664-1:2003, where the rated impulse-voltage test is chosen in accordance with 4.2 of this standard.

The 1,2/50 µs impulse voltage shall be applied three times for each polarity at intervals of 1 s minimum.

The test voltage shall be applied connecting each phase conductor of the main circuit in turn to the high-voltage terminal of the test supply. All other conductors of the main circuit and the auxiliary circuits shall be connected to the earthing conductor or the frame and to the earth terminal of the test supply.

There shall be no disruptive discharge during the tests.

6.2.2.3 Power-frequency voltage withstand test

The low-voltage interconnection shall be subjected to 1 min power-frequency voltage withstand tests in dry conditions in accordance with Table 10 of EN 60439-1:1999 with the following addition:

During the power-frequency voltage test, one terminal of the test transformer shall be connected to earth and to the main earthing conductor system of the CEADS.

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6.2.3 Dielectric tests on HV functional unit

Subclause 6.2 of EN 62271-200:2004 or EN 62271-201:2006 is applicable with the following addition:

In case that the design of CEADS does not allow to separate physically HV/LV transformer functional unit and HV functional unit, the tests of the HV functional unit shall be carried out with the HV/LV transformer functional unit isolated from the HV functional unit (e.g. by removing the interconnection).

6.2.4 Dielectric tests on HV/LV transformer functional unit

Tests prescribed in the EN 60076 series will be applicable, with the following considerations:

Preferably the HV/LV transformer functional unit should be disconnected from the HV functional unit and the LV functional unit. However for practical reasons the testing voltage can be applied through the HV functional unit. Only the switching devices that are in series in the supply circuit are closed. All other switching devices are open.

6.2.5 Dielectric tests on LV functional unit

Subclause 8.2.2 of EN 60439-1:1999 is applicable.

For practical reasons this test may be performed on the LV functional unit already installed in CEADS. In this case the LV functional unit shall be isolated from the HV/LV transformer functional unit.

6.2.6 Partial discharge test

By agreement between the manufacturer and the user a test to evaluate the insulation of the HV functional unit can be carried out following 6.2.9 of EN 62271-200:2004 or EN 62271-201:2006, depending on the type of insulation.

6.3 Temperature-rise tests

The purpose of this test is to check that the design of the CEADS in its entirety operates correctly and does not impair the life-time expectancy of the functional units and their interconnections. Their life-time expectancy will not be influenced if the acceptable limits of deterioration of insulation through thermal effects are not exceeded. As stated in Clause 3, the functional units, which form part of a CEADS, shall comply at least with the requirements of their respective standards. To ensure this compliance, the relevant type tests can be carried out on each functional unit, being alone or embedded in the CEADS. In addition, as stated in the introduction, potential interactions between devices have to be evaluated.

Two situations can be considered.

– The temperature rise tests are previously performed on each functional unit alone. Then the purpose of the temperature rise test on the complete CEADS is to assess the possible interactions, to define corresponding de-rating of the functional units if any, and to verify the temperature rise of the interconnections.

– The temperature rise tests are not previously performed on each functional unit alone. Then the purpose of the temperature test on the complete CEADS is to verify the temperature rise of the functional units according to their respective standards and at the same time the temperature rise of the interconnections.

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6.3.1 Test conditions

Main functional units and interconnections temperature-rise tests will be performed simultaneously on a complete CEADS. In the case of already type tested HV functional units and where it is considered that there is no significant influence of the temperature-rise of the HV functional unit on the other functional units, or vice-versa, the temperature rise test need not to include the current flowing in the main ring of the HV functional unit (see Figure 1). If there is a doubt, a complete test of the CEADS has to be performed (see Figure 2). For the HV functional unit the procedure of 6.5 of EN 62271-200:2004 or EN 62271-201:2006 shall be applied.

NOTE 1 Reasons for concern could be, for example, where the temperature rise values reported during the type test were close to the acceptable limits, or the influence of other functional units on the transformer feeder during the temperature rise test of the complete CEADS is so high that can be estimated that the influence on the main ring may compromise their rated values. In that case de-rating of the HV functional unit should be considered.

NOTE 2 It is a common practice that the HV functional unit operates at much lower current (load) than its rated one. Taking this into account, the additional increase of temperature caused by operating as part of a CEADS in most cases has no relevant influence on the required current capability of the HV functional unit. In cases where full load conditions are expected in the main ring this assumption would not be valid.

In case of HV functional units not previously type tested a complete temperature rise test of the CEADS has to be performed, according to Figure 2.

The test shall be carried out in a room in which the dimensions and insulation will keep the ambient air temperature of the room at less than 40 °C with a variation not exceeding 1 K in 1 h reading during the measurement test period.

The environment shall be substantially free from air currents, except those generated by heat from the equipment under test. In practice, this condition is reached when the air velocity does not exceed 0,5 m/s.

6.3.2 Test methods

Two situations are considered (see 6.3.1).

a) The temperature rise test need not to include the current flowing in the main ring of the HV functional unit because the temperature-rise test on the HV functional unit has been previously carried out and the influence of the other functional units is deemed to be not significant for the temperature-rise of the HV functional unit in the CEADS.

b) The temperature rise test has to include the current flowing in the main ring of the HV functional unit because the temperature-rise test on the HV functional unit has not been previously carried out or if the temperature-rise test on the HV functional unit had been previously carried out, the influence of the other functional units is deemed to be significant on the temperature-rise of the HV functional unit when installed in the CEADS.

The following test methods may be used.

The preferred one requires the use of independent sources of current to supply the HV and the LV sides of the CEADS.

An alternative method may be used if the laboratory can provide only one source of current or the design of the CEADS makes the connection arrangements as described by Figure 1 impossible. The alternative method only shall be applied in case of situation a).

6.3.2.1 Preferred method

This method requires different connections of supply for the HV and the LV sides respectively.

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6.3.2.1.1 Connection of supplies

a) HV side

According to the two situations described above following testing procedures shall be used.

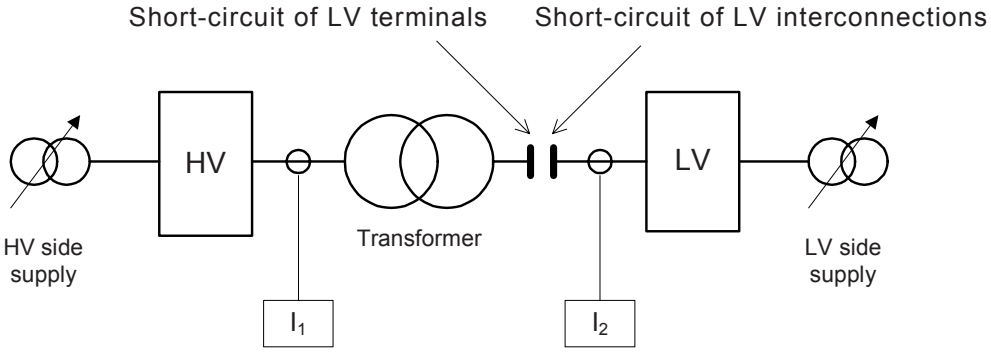
If the test does not require to include the current flowing in the main ring the HV/LV transformer functional unit and the HV functional unit shall be connected to one current supply and the low-voltage outgoing terminals of the HV/LV transformer functional unit shall be short-circuited. The supply shall be connected to the incoming feeder of the HV functional unit. Refer to Figure 1.

If the test requires to include the current flowing in the main ring it has to be isolated to the T-off (transformer feeder) and two different supplies are to be used. The first one shall supply the main ring with its rated current. The second shall supply the HV/LV transformer functional unit through the T-off of the HV functional unit and the low-voltage outgoing terminals of the HV/LV transformer functional unit shall be short-circuited. Refer to Figure 2.

b) LV side

The temperature-rise test on the LV side shall be carried out in accordance with 8.2.1 of EN 60439-1:1999 and the following specific requirements.

The LV functional unit shall be isolated from the HV/LV transformer functional unit, as close as practicable to the HV/LV transformer functional unit terminals. At a convenient point adjacent to the HV/LV transformer functional unit terminals, a short circuit shall be applied to the connections between the HV/LV transformer functional unit and the LV functional unit. Test current shall be applied to the LV functional unit via the outgoing feeders. The distribution of this supply current at the LV outgoing feeders shall be chosen to be the worst case in respect of heat generation. Refer to Figure 1 or Figure 2.

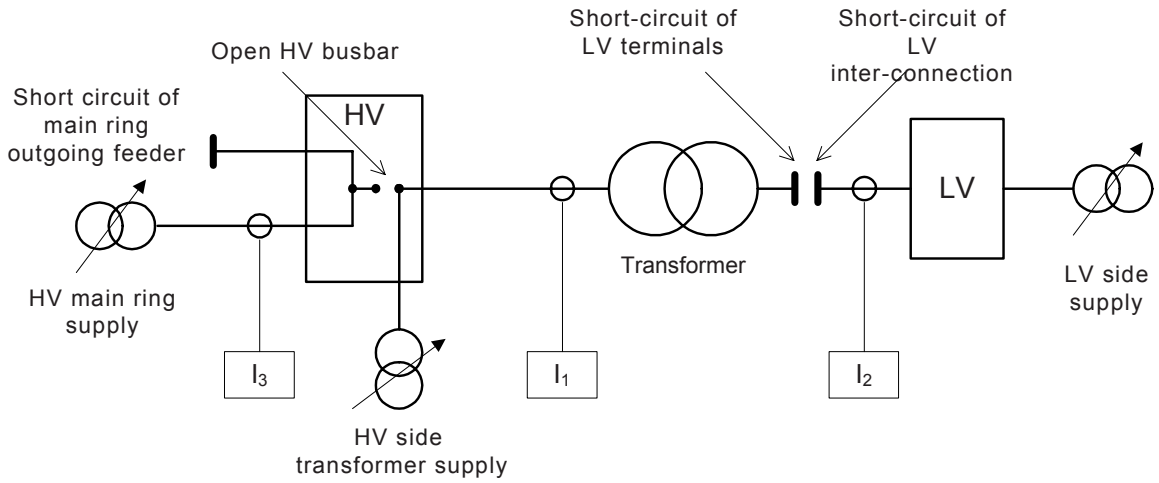


Key

I_1 = sufficient current to generate the total rated losses of liquid-filled transformer or HV rated current of dry-type transformers (see 6.3.3 step 2)

I_2 = LV rated current of transformer

Figure 1 – Test diagram in case of type tested HV functional unit



Key

I_1 = sufficient current to generate the total rated losses of liquid-filled transformer or HV rated current of dry-type transformers (see 6.3.3 step 2)

I_2 = LV rated current of transformer

I_3 = rated current of HV main ring

Figure 2 – Test diagram in case of non-type tested HV functional unit

6.3.2.1.2 Application of test currents

a) HV side

For liquid filled HV/LV transformer functional unit the circuit is supplied with sufficient current to generate the total rated losses of the HV/LV transformer functional unit, at its reference temperature.

NOTE 1 This test will require a small percentage of current above the rated current flowing through the complete circuit so as to compensate for the HV/LV transformer functional unit no-load loss.

NOTE 2 During the test, the resistance will vary according to the temperature of the HV/LV transformer functional unit. Thus, the test supply current should be varied accordingly to maintain the generated losses constant and equal to the total HV/LV transformer functional unit losses throughout the test.

For dry type HV/LV transformer functional units the simulated load method described in EN 60076-11 shall be followed (see 6.3.3).

b) LV side

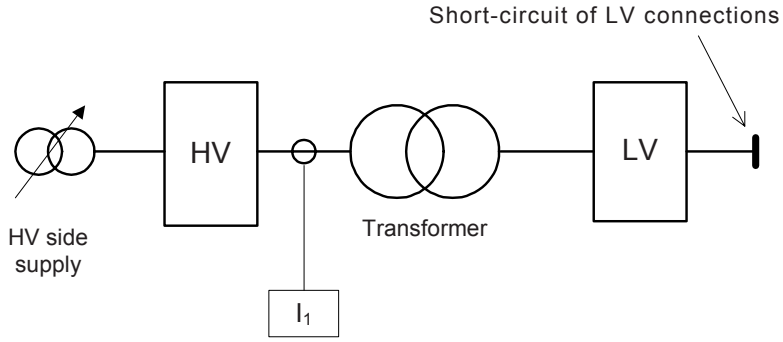
The low-voltage circuit is supplied with the rated low-voltage current of the tested HV/LV transformer functional unit.

6.3.2.2 Alternative method

This method requires one single supply.

6.3.2.2.1 Connection of supply

The HV functional unit and the HV/LV transformer functional unit shall be connected and the outgoing terminal of the LV functional unit shall be short-circuited. The supply shall be connected to the incoming terminals of the HV functional unit (see Figure 3).



Key

I_1 = sufficient current to generate the total rated losses of liquid-filled transformer or HV rated current of dry-type transformers (see 6.3.3 step 2)

Figure 3 – Alternative diagram in case of type tested HV functional unit

6.3.2.2.2 Application of test current

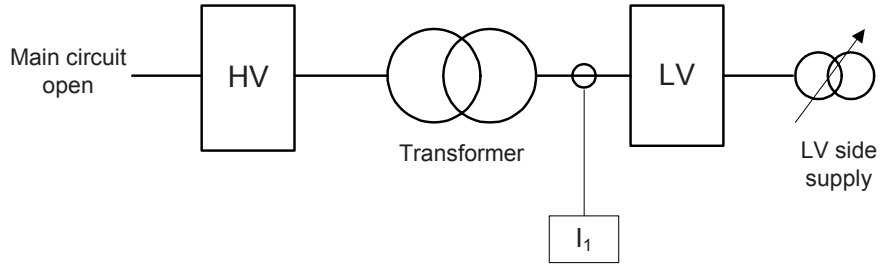
The CEADS is supplied with sufficient current to generate the total losses of the transformer, at its reference temperature, using the method defined in the relevant product standard.

6.3.3 Special case of dry-type HV/LV transformer functional unit

For a temperature-rise test on a CEADS equipped with a dry-type HV/LV transformer functional unit the method for the temperature-rise test should follow the simulated load method as described in EN 60076-11 consisting of two consecutive steps.

Step 1:

The rated operating voltage (three-phase) at rated frequency is applied to the low-voltage winding of the transformer via one of the outgoing feeders of the LV functional unit. The high-voltage winding is connected to the HV functional unit. HV main circuit is open (see Figure 4). After thermal equilibrium has been reached of the windings and magnetic core individual winding temperature-rises of the transformer shall then be measured.



Key

I_1 = no load current of the transformer

Figure 4 – Diagram for the open-circuit test

Step 2:

The connection of supplies is made according to 6.3.2.1.1 (Figure 1).

The HV side of the CEADS is supplied with the HV rated current of the HV/LV transformer functional unit. The LV side of the CEADS is supplied with the LV rated current of the HV/LV transformer functional unit.

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When the steady-state condition of the windings and magnetic core is obtained, the temperature rises of the individual windings are measured together with the temperature rises of the LV functional unit and the interconnections.

After completion of the two steps above the temperature rise is calculated by the formula given in 23.2.1 of EN 60076-11:2004.

6.3.4 Measurements

6.3.4.1 Measurements of the ambient air temperature

The ambient air temperature is the average temperature of the air surrounding the CEADS. It shall be measured during the last quarter of the test period by means of at least four thermometers, thermocouples or other temperature-detecting devices equally distributed around the CEADS at about the average height of its current-carrying parts and at a distance of about 1 m from the CEADS. The thermometers or thermocouples shall be protected against air currents and undue influence of heat.

In order to avoid indication errors because of rapid temperature changes, the thermometers or thermocouples may be put into small bottles containing about half a litre of oil.

During the last quarter of the test period, the change of ambient air temperature shall not exceed 1 K in 1 h. The ambient air temperature during tests shall be more than +10 °C but less than +40 °C. No correction of the temperature-rise values shall be made for ambient air temperatures within this range.

6.3.4.2 HV/LV transformer functional unit

In the case of already type tested HV/LV transformer functional unit, the top oil temperature rise for liquid-filled HV/LV transformer functional units shall be measured as given in EN 60076-2, or the average winding temperature rises for dry-type HV/LV transformer functional units shall be measured as given in EN 60076-11.

In addition to this, in the case of non type tested HV/LV transformer functional unit measurement of the temperature rise of the windings shall be performed according to EN 60076-2 or EN 60076-11. For this measurement, the diagram of Figure 1 has to be preferably used, or Figure 3 if only one supply source is available.

In the case of non type tested HV/LV dry-type HV/LV transformer functional unit the temperature rise is calculated by the formula given in 23.2.1 of EN 60076-11:2004.

6.3.4.3 LV functional unit

The LV functional unit temperature rise shall be measured as given in EN 60439-1:1999.

The air temperature in the location where electronic equipment may be installed shall be measured. The temperature must be within the service condition applicable to the contained electronic equipment.

6.3.4.4 HV functional unit

If this test is considered to be necessary or in case of non type tested HV functional unit (see 6.3.1) a complete measurement is to be performed according to EN 62271-200:2004 or EN 62271-201:2006.

The air temperature in the location where electronic equipment may be installed shall be measured. The temperature must be within the service condition applicable to the contained electronic equipment.

6.3.4.5 Interconnections

The temperature and temperature rise of the HV and LV interconnections and their terminals shall be measured.

6.3.4.6 Acceptance criteria

The CEADS is deemed to pass the test if

- the temperature rise of the HV/LV transformer functional unit does not exceed the requirements of EN 60076-2 for liquid-filled HV/LV transformer functional units or EN 60076-11 for dry-type HV/LV transformer functional units. If the liquid-filled HV/LV transformer functional unit has been tested previously only the top oil temperature needs to be checked,
- the temperature rises and temperatures of the HV functional units and HV interconnection do not exceed the requirements of EN 62271-1:2008,
- the temperature rises and temperatures of the LV functional unit and LV interconnection do not exceed the requirements of EN 60439-1:1999,
- for the accessible parts of CEADS the temperature rises and temperatures do not exceed the requirements of Table 3 of EN 62271-1:2008. If the values are exceeded additional precautions shall be taken on site to avoid the risk of burns.

6.4 Measurement of resistance of the main circuit of the HV functional unit

Subclause 6.4.1 of EN 62271-200:2004 or EN 62271-201:2006 is applicable.

NOTE This enables the results to be used by the manufacturer in support of the values and tolerances declared for CEADS when subjected to routine tests.

6.5 Short-time and peak withstand current tests on main and earthing circuits

6.5.1 Short-time and peak withstand current tests on main circuit of HV and LV functional units

The HV functional unit that has not been previously tested shall be submitted to test according to EN 62271-200:2004 or EN 62271-201:2006. The HV functional unit shall be isolated from the HV/LV transformer functional unit to perform the test.

The LV functional unit that has not been previously tested shall be submitted to test according to EN 60439-1:1999. The LV functional unit shall be isolated from the HV/LV transformer functional unit to perform the test.

6.5.2 Short-time and peak withstand current tests on HV and LV interconnections

HV interconnections shall be tested following the procedure described in 6.6 a) of EN 62271-200:2004 or EN 62271-201:2006. The test currents will be applied in such a manner that the complete connection to the transformer is tested. All parts supporting the interconnection shall be maintained in place, as in service condition, during the test.

In particular, when the HV interconnection is protected by current-limiting devices situated in the HV switchgear, provisions of 6.6 a) of EN 62271-200:2004 or EN 62271-201:2006 are applicable.

If the HV interconnection is not protected by current limiting devices, the test can be made, where appropriate, at the same time as the HV functional unit provided that the conditions of 6.6.1 of EN 62271-200:2004 or EN 62271-201:2006 are met.

Non type-tested LV interconnections can be tested following the procedure described in EN 60439-1:1999 for LV functional unit. Where appropriate this test can be made at the same time as the LV functional unit. The test currents will be applied in such a manner that the complete connection to the transformer is tested. All parts supporting the interconnection shall be maintained in place, as in service condition, during the test.

6.5.3 Short-time and peak withstand current tests on earthing circuits

The earthing conductor system of the CEADS shall be tested according to EN 62271-1:2008 with the addition of the following paragraphs:

It is not required to repeat the type tests on the main earthing circuits of type-tested functional units.

After the test, some deformation of the main earthing conductor and of the connections to the functional units is permissible, but the continuity of the circuit shall be preserved.

Generally, no test of the connections of metallic covers and doors, if any, to the main earthing conductor is required, if adequate design is demonstrated. However, in case of doubt, they shall be tested at 30 A (d.c.). The voltage drop shall be lower than 3 V.

6.5.4 Short-time and peak withstand current tests on HV/LV transformer functional unit

By agreement between the manufacturer and the user a short circuit test according to EN 60076-5 on the HV/LV transformer functional unit might be carried out.

Preferably the HV/LV transformer functional unit should be disconnected from the HV functional unit and the LV functional unit. However for practical reasons the testing voltage can be applied through the HV functional unit. Only the switching devices that are in series in the supply circuit are closed. All other switching devices are open.

6.6 Functional tests

It shall be proved that it is possible to perform installation, commissioning and all the necessary operational and maintenance activities on the CEADS.

As an example a typical list of these activities includes:

- operation of the switchgear and controlgear;
- fixing of insulating barriers;
- checking of temperature and liquid level of the HV/LV transformer functional unit;
- voltage indication check;
- fitting of earthing devices;
- cable testing;
- replacement of fuses, if any;
- operation of the HV/LV transformer functional unit tap-changer;
- interlocks.

6.7 Verification of the degree of protection, the resistance to mechanical impacts and calculation of other mechanical stresses

6.7.1 Verification of degree of protection (IP coding)

The degree of protection specified by the manufacturer for any enclosure within the CEADS shall be verified according to EN 60529.

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6.7.2 Verification of resistance to mechanical impacts (IK coding)

In accordance with the requirements specified in EN 62262, test shall be performed on the HV functional units as under service conditions. Testing values stated in 5.13.3 of EN 62271-1:2008 are applicable.

Verification of the resistance to mechanical impacts of other parts of the CEADS may be carried out by agreement between the user and the manufacturer.

6.7.3 Wind pressure

For CEADS intended for outdoor installation the mechanical effects of wind pressure may be verified by calculation.

6.7.4 Other mechanical stresses

Any possible load that can be expected to occur in service, depending on the intended application, may be verified by calculation. The design shall ensure stability during installation and operation.

6.8 Internal arcing tests

These tests are applicable to CEADS, intended to be qualified as class IAC/HV with respect to protection of persons in the event of an internal arc at HV side. The tests shall be performed according to Annex A.

CEADS are generally intended for installation in closed electrical operating areas, where, in principle, only authorised personnel can enter. However the workers of a factory, not in charge of the operation of the HV switchgear, can stand occasionally in the proximity of a CEADS. As they are not aware of the risks involved, they are considered to be general public in the context of this standard. Consequently the standard considers both accessibility types A and B, as in EN 62271-200:2004 or EN 62271-201:2006.

These tests cover the cases of faults resulting in an arc occurring inside the CEADS in the HV functional unit and the HV interconnection.

The validity of the results of a test carried out in a particular CEADS design or representative part of it can be extended to another one (refer to 6.1), provided that the original test was more onerous and the latter design can be considered as similar to the one tested in all the following respects:

- arc current and arcing time;
- directions of gas flow from the internal arc;
- dimensions of the tested compartments and layout of the CEADS;
- structure and strength of the compartments and partitions, if any;
- performance of the pressure release device, if any.

The internal arcing test shall be performed on a complete CEADS to ensure that the influence of all devices is represented. If any device is used to limit the duration of the arc (for example protection relay, fuses), it may be operative during the test but the part of the CEADS protected by the device shall be classified per the actual duration of the arc.

6.9 Electromagnetic compatibility tests (EMC)

For HV functional unit 6.9 of EN 62271-1:2008 is applicable with the exception of radio interference voltage test. For LV functional unit 7.10 of EN 60439-1:1999 is applicable.

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6.10 Additional tests on auxiliary and control circuits

6.10.1 General

Subclause 6.10 of EN 62271-1:2008 is applicable, with the following addition:

These tests will be performed on the complete CEADS, and are only applicable to the auxiliary and control LV circuits. LV power circuits, i.e. secondary of transformer, interconnection and LV functional unit, are excluded from the test.

6.10.2 Functional tests

A functional test of all low-voltage circuits shall be made to verify the proper functioning of auxiliary and control circuits in conjunction with the other parts of the CEADS.

The tests shall be performed with the upper and lower value limits of the supply voltage

For low-voltage circuits, sub-assemblies and components, operation tests can be omitted if they have been fully performed during a test applied to similar CEADS.

6.10.3 Electrical continuity of earthed metallic parts test

Subclause 6.10.3 of EN 62271-1:2008 is applicable.

6.10.4 Verification of the operational characteristics of auxiliary contacts

Subclause 6.10.4 of EN 62271-1:2008 is applicable.

6.10.5 Environmental tests

Subclause 6.10.5 of EN 62271-1:2008 is partly applicable on a representative auxiliary and control circuit.

When the tests as stated in 6.10.5 of EN 62271-1:2008 are performed on the separate components of a representative auxiliary and control circuit no further environmental tests are needed.

Where this is not carried out, the remaining subclauses of 6.10.5 of EN 62271-1:2008 are applicable on a typical lay out of the auxiliary and control circuits.

6.10.6 Dielectric test

Subclause 6.10.6 of EN 62271-1:2008 is applicable.

6.101 Verification of making and breaking capacities

Subclause 6.101 of EN 62271-200:2004 or EN 62271-201:2006 is applicable with the following addition:

It is not required to repeat the type tests to verify making and breaking capability on previously type tested components, provided that the service conditions in the CEADS are similar to the testing conditions. Possible mechanical, thermal and electrical influences have to be considered.

6.102 Mechanical operation tests

Subclauses 6.102 of EN 62271-200:2004 and 8.26 of EN 60439-1:1999 are applicable respectively to HV functional unit and LV functional unit with the following addition:

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Mechanical operation test need not be repeated if the functional units have been previously type tested, provided that the installation of the functional unit within the CEADS does not impose conditions that could influence negatively the operation. In case of doubt the test shall be repeated in the real installation conditions.

6.103 Pressure withstand test for gas-filled compartments

Subclause 6.103 of EN 62271-200:2004 is applicable with the following addition:

It is not required to repeat the pressure withstand test for gas-filled compartments on type tested components.

6.104 Measurements of leakage currents of non-metallic enclosures

When the HV interconnection is totally or partially covered by a non-metallic enclosure the following tests shall be made in order to check compliance with the requirement of item d) of 6.2.1.6.

At the discretion of the manufacturer the main circuit shall be connected either to a three-phase supply of power-frequency voltage equal to the rated voltage of the HV functional unit, with one phase connected to earth, or to a single-phase supply of a voltage equal to the rated voltage, the live parts of the main circuit being connected together. For three-phase tests, three measurements shall be made with the different phases of the supply successively connected to earth. In the case of single-phase tests, only one measurement is necessary.

A metal foil shall be placed in the most unfavourable situation for the test on the accessible surface of the insulation providing the protection against contact with live parts. In case of doubt about the most unfavourable situation, the test shall be repeated with different situations.

The metal foil shall be approximately circular or square, having an area as large as possible but not exceeding 100 cm². The enclosure and the frame of the metal-enclosed switchgear and controlgear shall be earthed. The leakage current flowing through the metal foil to earth shall be measured with the insulation dry and clean.

If the value of the leakage current measured is more than 0,5 mA, the insulating surface does not provide the protection required in this standard.

It is not necessary to measure leakage currents, if earthed metal parts are arranged in an appropriate manner to ensure that leakage currents cannot reach the accessible parts of the enclosure.

6.105 Weatherproofing test

When agreed between manufacturer and user, a weatherproofing test can be made on CEADS. A recommended method for outdoor installation is given in Annex C of EN 62271-1:2008.

6.201 Tightness and mechanical strength for liquid filled compartments

Subclause 8.1.1 of EN 50464-1:2007 is applicable. If the enclosure is of hermetically sealed type, Clause 4 of EN 50464-4:2007 is applicable. The following addition will apply to both clause and subclause:

The test shall be performed on a complete CEADS to ensure that the influence of all devices is represented.

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7 Routine tests

The routine tests shall be made on each complete CEADS at the manufacturer's factory to ensure that the product is in accordance with the equipment on which the type tests have been carried out.

Due to the special design of this equipment it may be practical to test more than one functional unit at the same time.

The routine tests comprise the following:

- dielectric tests (7.1);
- tests on auxiliary and control circuits (7.2);
- measurement of the resistance of the main circuit (7.3);
- tightness test for the HV functional unit, where applicable (7.4):
- design and visual checks (7.5);
- mechanical operation test on HV functional units (7.101);
- pressure tests of gas-filled compartments (7.102);
- tests of auxiliary, pneumatic and hydraulic devices (7.103);
- measurement of the resistance of the windings (7.201);
- measurement of the voltage ratio (7.202);
- measurement of the short circuit impedance and load losses (7.203);
- measurement of non-load losses and current (7.204):
- inspection of the LV functional unit, including inspection of wiring and, if necessary, electrical operation test (7.301);
- checking of protective measures and of the electrical continuity of the protective circuits (7.302);
- tests after assembly onsite (7.6).

7.1 Dielectric tests

Only parts of CEADS not previously routine tested shall be tested.

7.1.1 Dielectric tests on HV functional unit

The tests will be carried out with the HV/LV transformer functional unit isolated from the HV functional unit. For this purpose the switching device of the transformer feeder circuit, if any, shall be in open position.

In this case, for practical reasons, the switching device of the transformer feeder circuit will not be part of the tested equipment. Therefore it shall be tested together with the HV/LV transformer functional unit as stated in 7.1.2. Test voltage values will be those of the HV/LV transformer functional unit. A test with the switching device of the transformer feeder circuit in open position shall be included. The following tests are applicable:

- dielectric tests (7.1 of EN 62271-1:2008).

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7.1.2 Dielectric tests on HV/LV transformer functional unit and HV interconnection

The testing voltage will be applied through the HV functional unit or the LV functional unit. Only the switching devices that are in series in the supply circuit are closed, all other switching devices are in open position. The following tests are applicable:

– separate-source a.c. withstand voltage test (Clause 11 of EN 60076-3:2001);

– induced a.c. withstand voltage test (12.2.1 of EN 60076-3:2001).

7.1.3 Dielectric tests on LV functional unit and LV interconnection

As the purpose of this test is to test only the LV functional unit and LV interconnection, the LV interconnection will be disconnected from the HV/LV transformer functional unit. The testing voltage will be applied at the HV/LV transformer functional unit side of the LV interconnection. The switching devices that are in series in the supply circuit are closed.

The following tests are applicable:

– dielectric tests (8.3.2 of EN 60439-1:1999);

– verification of insulation resistance (8.3.4 of EN 60439-1:1999).

7.2 Tests on auxiliary and control circuits

Subclause 7.2 of EN 62271-1:2008 is applicable.

7.3 Measurement of the resistance of the HV main circuit

This test shall be carried out in the main ring as described in 7.3 of EN 62271-200:2004.

7.4 Tightness test for the HV functional unit

In the case that they have been routine-tested according to their relevant standards, there is no need to conduct this test.

In other case, a tightness test as stated in 7.4 of EN 62271-1:2008 shall be carried out.

7.5 Design and visual checks

Subclause 7.5 of EN 62271-1:2008 is applicable.

7.6 Tests after assembly on site

In the exceptional case mentioned in the second paragraph of clause 1.1 (Scope) additional tests may be made on site by agreement between manufacturers and user, to assure that the assembly process has been carried out correctly.

7.101 Mechanical operation tests on HV functional unit

Subclause 7.102 of EN 62271-200:2004 or EN 62271-201:2006 is applicable.

7.102 Pressure tests of gas-filled compartments

Subclause 7.103 of EN 62271-200:2004 or EN 62271-201:2006 is applicable.

7.103 Tests of auxiliary electrical, pneumatic and hydraulic devices

Subclause 7.104 of EN 62271-200:2004 or EN 62271-201:2006 is applicable.

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7.201 Measurement of the resistance of the windings

If the HV/LV transformer functional unit has not been previously routine tested, 10.2 of EN 60076-1:1997 or Clause 15 of EN 60076-11:2004 shall be applied.

7.202 Measurement of the voltage ratio

If the HV/LV transformer functional unit has not been previously routine tested, 10.3 of EN 60076-1:1997 or Clause 16 of EN 60076-11:2004 shall be applied.

7.203 Measurement of the short circuit impedance and load losses

If the HV/LV transformer functional unit has not been previously routine tested, 10.4 of EN 60076-1:1997 or Clause 17 of EN 60076-11:2004 shall be applied.

7.204 Measurement of no-load losses and current

If the HV/LV transformer functional unit has not been previously routine tested, 10.5 of EN 60076-1:1997 or Clause 18 of EN 60076-11:2004 shall be applied.

7.301 Inspection of the LV functional unit, including inspection of wiring and, if necessary, electrical operation test

If the LV functional unit has not been previously routine tested, 8.3.1 of EN 60439-1:1999 shall be applied.

7.302 Checking of protective measures and of the electrical continuity of the protective circuits of the LV functional unit

If the LV functional unit has not been previously routine tested, 8.3.3 of EN 60439-1:1999 shall be applied.

8 Guide to the selection of CEADS for service

CEADS may be constructed in various forms that have evolved with changing technologies and functional requirements. The selection of CEADS essentially involves an identification of the functional requirements for the service installation that best meets these requirements.

Such requirement should also take account of applicable legislation and user safety rules.

Tables 3 to 5 provide a summary of the considerations for specifying CEADS.

8.1 Selection of rated values

For a given duty in service, the CEADS is selected by considering the individual rated values of its components required by normal load condition and in the case of fault conditions.

8.2 Selection of Internal Arc Classification

When selecting a CEADS, the probability of internal faults should be properly addressed, with the aim to provide an acceptable protection level for operators and for the general public.

This protection is achieved by reducing the risk to a tolerable level. According to ISO/IEC Guide 51:1999, risk is the combination of the probability of occurrence of harm and the severity of the harm. (Refer to Clause 5 of ISO/IEC Guide 51:1999 on the concept of safety).

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Therefore, the selection of a suitable CEADS, in relation to an internal fault leading to an arc, should be governed by a procedure to achieve a tolerable level of risk. Such a procedure is described in Clause 6 of ISO/IEC Guide 51:1999. This procedure is based on the assumption that the user has a role to play in the risk reduction.

For guidance, Table 1 gives a list of locations where experience shows that faults are most likely to occur. It also gives possible causes of failure and possible measures to decrease the probability of internal arc faults. Other measures may be adopted to provide the highest possible level of protection to persons in the case of an internal arc. These measures are aimed to limit the external consequences of such an event. Table 2 gives examples of measures limiting the consequences of internal arc faults.

The effectiveness of the design of the CEADS to provide protection to persons in case of an internal arc can be verified by testing according to Annex A. CEADS which have been successfully tested qualify as Internal Arc Class IAC/HV-A and/or IAC/HV-B.

IAC/HV-A is intended to verify the protection of operators when operating the CEADS and is based on a restriction to authorised persons only (Accessibility Type A, see A.2.1).

IAC/HV-B is intended to verify the protection of the general public around the CEADS with unrestricted access (Accessibility Type B, see A.2.2).

For both classes it is important to realise, that the test for Internal Arc Classification relates to a given configuration of the CEADS in respect of type and position of the HV/LV transformer functional unit, HV functional unit and LV functional unit. The outcome of the test is dependent of the specific type of switchgear in the CEADS. The decision of an Internal Arc Classification restricts the free choice of HV functional unit in the CEADS.

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Table 1 – Locations, causes and examples of measures decreasing the probability of internal arc faults

(1)	(2)	(3)
Locations where internal faults are most likely to occur	**Possible causes of internal faults**	**Examples of possible preventive measures**
Cable compartments	Inadequate design	Selection of adequate dimensions. Use of appropriate materials.
	Faulty installation	Avoidance of crossed cables connections. Checking of workmanship on site. Correct torque.
	Failure of solid or liquid insulation (defective or missing)	Checking of workmanship and/or dielectric test on site. Regular checking of liquid levels, where applicable.
Disconnectors Switches Earthing switches	Mal-operation	Interlocks. Delayed reopening. Independent manual operation. Making capacity for switches and earthing switches. Instructions to personnel.
Bolted connections and contacts	Corrosion	Use of corrosion inhibiting coating and/or greases. Use of plating. Encapsulation, where possible.
	Faulty assembly	Checking of workmanship by suitable means. Correct torque. Adequate locking means.
Instrument transformers	Ferroresonance	Avoidance of these electrical influences by suitable design of the circuit.
	Short circuit on LV side of VT	Avoid short circuit by proper means e.g. protection cover, LV fuses.
Circuit breakers	Insufficient maintenance	Regular programmed maintenance. Instructions to personnel.
All locations	Error by personnel	Limitation of access by compartmentalisation. Insulation embedded live parts. Instructions to personnel.
	Ageing under electric stresses	Partial discharge routine tests.
	Pollution, moisture, ingress of dust, vermin, etc.	Measures to ensure that the specified service conditions are achieved (refer to Clause 2). Use of gas-filled compartments.
	Overvoltages	Surge protection. Adequate insulation co-ordination. Dielectric tests on site.
Interconnections	Failure of insulation	Use of adequate clearances, phase to phase and phase to ground Use of insulated interconnections, shielded type preferred.

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Table 2 – Examples of measures limiting the consequences of internal arc faults

Rapid fault clearance times initiated by detectors sensitive to light, pressure or heat or by differential busbar protection.
Remote control.
Pressure relief devices, pressure resistant enclosure (including doors, floors, ventilation grids etc.).
Application of transformer protection with individual circuit-breaker or suitable fuses in combination with switching devices limiting the let-through current and fault duration.
Gas flow control and cooling devices.

As a guide for the selection of an adequate CEADS, with respect to internal arc faults, the following criteria may be used:

– where the risk due to an internal arc fault is considered negligible: a CEADS class IAC/HV-A and/or IAC/HV-B is not necessary;

– where the risk due to an internal arc fault is considered to be relevant: only CEADS class IAC/HV-A and/or IAC/HV-B should be used.

For the second case, the selection should be made by taking into account the foreseeable maximum level of current and duration of the fault, in comparison with the rated values of the tested equipment.

Parts of a CEADS protected by devices that limit the duration of the fault may be tested with such devices operative and then, after passing the test, IAC/HV rated for the actual duration of the arc. If the remaining parts of the CEADS are rated to the maximum level of current and duration of the fault foreseeable in the network, it is admissible to take advantage of the operation of the protection and use the CEADS in this application by agreement between the user and the manufacturer.

In addition, the installation instructions of the manufacturer should be followed (refer to Clause 10).

The location of personnel during an internal arc event is important. The manufacturer should indicate which parts of the CEADS are accessible, according to the testing arrangement and the user should follow the instruction carefully. Allowing personnel to enter an area not designated as accessible may lead to the risk of personnel injury.

Internal arc classification gives a tested level of protection of persons under normal operating conditions as defined in Clause A.1. It is not concerned with personnel protection under maintenance conditions or with service continuity.

8.3 Information

The following tables provide a summary of the considerations for specifying CEADS ratings.

Table 3 – Summary of technical requirements, ratings for CEADS – Service conditions

Information		(Sub)clause of this standard	Reference to	User requirements as appropriate
Ambient air temperature: Average Minimum Maximum	 °C °C °C	2	EN 62271-1:2008	
Solar radiation	W/m²		IEC 60721-2-4	
Altitude	m		HV:EN 62271-1:2008	
Pollution	Level		IEC/TS 60815	
Ice coating			EN 62271-1:2008	
Wind-driven sand			IEC 60721-2-2	
Wind-driven snow			IEC 60721-2-2	
Wind	m/s		EN 62271-1:2008	
Condensation or precipitation			IEC 60721-2-2	
Vibration			IEC/TR 62271-300	
Risk of earth tremors			IEC/TR 62271-300	
Risk of other vibrations			EN 60721-1	
Induced electromagnetic disturbance in secondary system	Class		EN 62271-1:2008	

Table 4 – Summary of technical requirements, ratings for CEADS – Ratings of the CEADS

Information		(Su)clause of this standard	Reference to	User to indicate requirement as appropriate
Rated voltages HV LV	 kV V	4.1	EN 60076-1:1997	
Nominal voltages HV LV	 kV V	9.1		
Number of phases		9.1		
Type of HV neutral earthing Maximum expected value of earth fault current	 kA	9.1	User	
Type of LV neutral earthing Maximum expected value of earth fault current	 kA	9.1	User	
Rated power of the CEADS	kVA	4.10	EN 60076-1	
Sound level	dB	Annex B	EN 60076-10	

Table 4 – Summary of technical requirements, ratings for CEADS – Ratings of the CEADS *(continued)*

Information		(Su)clause of this standard	Reference to	User to indicate requirement as appropriate
Internal arc classification	IAC/HV	5.4.4		Y/N
Classified sides	F/L/R			
Accessibility type A				
Fault current and duration	kA, s			
Accessibility type B				
Fault current and duration	kA, s			
Rated insulation levels				
Common value	kV or V	4.2	EN 60076-3:2001	
Rated short-duration power-frequency withstand voltage	kV or V			
Rated lightning impulse withstand voltage	kV or V			
Across isolating distance			EN 62271-1:2008	
HV:	kV or V		EN 60439-1:1999	
LV:	kV or V		EN 60947-1	
Rated short-duration power-frequency withstand voltage	kV or V			
Rated lightning impulse withstand voltage	kV or V			
Rated frequency	Hz	4.3		
Rated normal current		4.4		
HV:	A		EN 62271-1:2008	
LV:	A		EN 60439-1:1999	
Rated short-time withstand current		4.5		
HV:	kA		EN 62271-1:2008	
LV:	kA		EN 60439-1:1999	
Earthing circuit:	kA		EN 62271-1:2008	
Rated peak withstand current		4.6		
HV:	kA		EN 62271-1:2008	
LV:	kA		EN 60439-1:1999	
Earthing circuit:	kA		EN 62271-1:2008	
Rated duration of short-circuit		4.7		
HV:	s		EN 62271-1:2008	
LV:	s		EN 60439-1:1999	
Transformer:	s		EN 60076-5:2006 EN 60076-11	
Earthing circuit:	s		EN 62271-1:2008	

Table 4 – Summary of technical requirements, ratings for CEADS – Ratings of the CEADS *(continued)*

Information		(Su)clause of this standard	Reference to	User to indicate requirement as appropriate
Rated supply voltage of closing and opening devices and of auxiliary and control circuits Closing and tripping: Indication: Control:	HV LV V V V	4.8	EN 62271-1:2008 EN 60439-1:1999	
Rated supply frequency of closing and opening devices and of auxiliary circuits HV: LV:	 Hz Hz	4.9	 EN 62271-1:2008 EN 60439-1:1999	

Table 5 – Summary of technical requirements, ratings for CEADS – Design and construction of the CEADS

CEADS		(Sub)clause of this standard	Reference to	User to indicate requirement as appropriate
Degree of protection of the HV/LV transformer functional unit for indoor application Degree of protection of the HV/LV transformer functional unit for outdoor application Degree of protection of the dry type HV/LV transformer functional unit Degree of protection of exposed conductors and/or bushings		5.4.1	EN 60529	
Type of CEADS Type of components: HV switchgear LV switchgear Transformer	G/A/I	1.3.1	User	
Rated values of transformer Power Load loss P_{cu} No-load loss P_0 No-load current I_0 Short-circuit impedance Temperature rise Insulation	 kVA W W A % K	4.10	EN 60076-1 EN 60076-11 EN 60076-2 EN 60076-3:2001	
Materials of the enclosures		5.5	EN 50464 series EN 62271-200:2004 EN 62271-201:2006	
Surface treatment of the enclosures		9.1		
Mechanical impact energy	J	5.4.2	EN 62271-1:2008	
Mechanical stresses by snow load of the roof roof loads wind pressure	 N/m² N/m² N/m²	9.1	EN 62271-1:2008	
Dimensions and weights Length Width Height Mass of each transport unit Total mass of the CEADS	 mm mm mm kg kg	9.2		

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9 Information to be given with enquiries, tenders and orders

This clause lists the information, which is necessary to enable the user to make an appropriate enquiry for a CEADS and the supplier to give an adequate tender.

9.1 Information with enquiries and orders

When enquiring about or ordering a CEADS, the scope of supply should be defined for all equipment and services. This may include training, technical and layout studies and requirements for co-operation with the supplier. The following information should be supplied by the enquirer:

a) Particulars of the system:

Nominal and highest voltages, frequency, types of system neutral earthing.

b) Service conditions:

Minimum and maximum ambient air temperature; any condition deviating from the normal service conditions or affecting the satisfactory operation of the equipment, as, for example, altitudes higher than 1 000 m, rapidly changing temperatures, wind-driven sand and snow, the unusual exposure to vapour, moisture, fumes, explosive gases, excessive dust or salt (e.g. caused by traffic or industrial pollution), the risk of earth tremors or other vibrations due to external causes to the equipment to be delivered.

c) Particulars and electrical characteristics of the CEADS:

1) rated operating voltages;

2) rated power of the CEADS;

3) rated frequency;

4) rated insulation levels;

5) rated short-time withstand currents;

6) rated duration of short-circuit (if different from 1 s);

7) rated peak withstand currents;

8) rated values of functional units (HV functional unit, LV functional unit, HV/LV transformer functional unit and interconnections);

9) number of phases;

10) type of functional units (e.g. air or gas-insulated cubicle type switchgear and controlgear, liquid-immersed transformer);

11) circuit diagrams;

12) degree of protection of the enclosures and partitions if any;

13) material and surface treatment of the enclosures;

14) mechanical stresses (e.g. snow loads, roof loads, wind pressure, etc.);

15) maximum admissible dimensions and special requirements affecting the layout of the CEADS (general arrangement);

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16) the maximum expected value of earth-fault currents dependent upon the type of HV and LV systems neutral earthing employed or the short-circuit current ratings applicable to the earthing circuit(s);

17) Internal arc classification (if any), including value of the test current and duration.

Beyond these items the enquirer should indicate every condition which might influence the tender or the order, as, for example, special mounting or erection conditions (e.g. vicinity of surrounding walls, elements that can affect ventilation, etc.), the location of the external high-voltage connections, local fire and sound regulations, and expected lifespan. Information should be supplied if special type tests are required. Special conditions in case of installation within a factory (e.g. installation in areas accessible to workers, the existence of areas not protected in case of internal arc above or below the installation place of the CEADS where workers can stay or walk, etc.).

9.2 Information with tenders

The following information should be given by the manufacturer with descriptive matters and drawings:

a) rated values and characteristics as enumerated in items b) and c) of 9.1;

b) list of type test, and the corresponding certificates or reports on request, including the justification of the selection of internal arc tests for IAC/HV-A and/or IAC/HV-B, where applicable;

c) constructional features, for example:

1) mass of each transport unit;

2) total mass of the CEADS;

3) overall dimensions and the layout (general arrangement) of the CEADS;

4) information of the arrangement of the external connections;

5) transport and installation requirements;

6) information on operation and maintenance;

7) information required by the relevant standard of the components;

8) minimum recommended clearances around the CEADS;

9) volume of the fluid retention tank (if any);

10) accessible sides and particular installation instructions to prevent access to the HV/LV transformer functional unit in case of a CEADS accessible to the public (Special case of installation inside a factory);

11) type of gas-pressure or liquid-pressure system;

12) rated filling level and minimum functional level.

d) List of recommended spare parts which parts, which should be procured by the user on request;

e) Relevant characteristics of the functional units of the CEADS, and if applicable, the surface treatment or coating of the enclosures, and the tests carried out to assess their performance under specified environmental conditions;

f) Statement declaring that the CEADS complies with this standard.

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10 Rules for transport, installation, operation and maintenance

It is essential that the transport, storage and erection of a CEADS or its transport units, as well as their operation and maintenance in service, are performed in accordance with instructions given by the manufacturer.

Consequently, the manufacturer should provide instructions for the transport, storage, erection, operation and maintenance of a CEADS. The instructions for the transport and storage should be given at a convenient time before delivery, and the instructions for the erection, operation and maintenance should be given by the time of delivery at the latest.

Relevant standards for the different components define particular rules for their transport, erection, operation and maintenance, and these should be included in the general instructions for the CEADS, where applicable.

The following information is given to supplement these instructions with the most important additional instructions to be provided by the manufacturer of CEADS.

10.1 Conditions during transport, storage and installation

A special agreement should be made between manufacturer and user if the service conditions specified in the order cannot be guaranteed during transport, storage and erection. In particular, instructions should be given to protect insulation against undue moisture absorption or irreversible pollution, if the environmental conditions prior to energizing are such that the enclosures cannot provide appropriate protection.

It might also be necessary to give guidance and/or provide special elements to secure components to avoid any damage due to foreseen vibration or shocks during transport.

10.2 Installation

For each type of CEADS, the instructions provided by the manufacturer should at least include the following points.

10.2.1 Unpacking and lifting

The mass of each transport unit, including details of any special lifting devices required for safe lifting and unpacking should be labelled on the equipment.

10.2.2 Assembly

In principle the CEADS are transported as a unit fully assembled. Therefore there is no need to assemble at the installation on site. However if by agreement between manufacturer and user the CEADS is not fully assembled for transport, all transport units should be clearly marked, and drawings showing assembly of these units should be provided.

10.2.3 Mounting

The manufacturer should provide all necessary information to enable site preparation to be completed, as for example:

– required civil work;

– external earthing terminals;

– position of the cable access points;

– minimum recommended clearances around the CEADS.

NOTE CEADS may be used for power supply inside factories. In such plants it is likely to occur that workers not involved in operation of CEADS (general public) come in close vicinity above or below the CEADS, e.g. the CEADS is installed below a grid made steel staircase. In such cases access from top or below the CEADS shall be considered.

10.2.4 Final installation inspection

Instructions for inspection and test of the CEADS after its installation and connection, which should include at least a list of recommended tests, made at site.

10.3 Operation

Besides the particular operating instructions of each component, the manufacturer should provide the following additional information, so that the user can acquire an adequate understanding of the main principles involved:

- a description of the safety features of the CEADS, and a list of any special means or tools supplied for safety purposes, and their instructions for use;
- the operation of, interlocks and padlocking facilities;
- when fluids are used in CEADS, as far as practicable, instruction should be provided in order to allow the user to
  - minimise the leakage rate,
  - control the handling of the new and used fluids.

10.4 Maintenance

The manufacturer shall issue a maintenance manual, including at least the following information:

- complete maintenance instructions for main components, as required in relevant standards;
- maintenance instructions, if any, for the enclosures, including frequency and procedure for maintenance.

10.5 Dismantling, recycling and disposal at the end of service life

The manufacturer should provide relevant information to allow the end user to carry out dismantling, recycling and disposal of the CEADS at the end of life. This will take into account the protection of both the workers and the environment.

11 Safety

Clause 11 of EN 62271-1:2008 is applicable with the following additions:

A CEADS provides the specified level of protection to operators and general public only when installed and operated in accordance with the manufacturer’s instructions. Additionally the user may set up specific procedures for installation and operation.

Safety aspects of functional units are covered by the relevant product standards.

The following clauses of this standard describe additional features providing protection to operators and general public against various hazards:

11.1 Electrical aspects

- Earthing (indirect contact) (see 5.1).
- Degree of protection (direct contact) (see 5.4.1 and 6.7.1).

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11.2 Mechanical aspects

– Degree of protection (see 5.4.2 and 6.7.2).

11.3 Thermal aspects

– Maximum temperature of accessible parts (see 6.3.4.6).

11.4 Internal arc aspects

– Internal arc fault (see 5.4.4).

12 Influence of the product on the environment

The following sub-clauses of this standard contains provisions to protect the environment from potential negative influence of the CEADS:

– operation (see 10.3);

– dismantling, recycling and disposal at the end of service life (see 10.5).

Annex A
(normative)

Method for testing CEADS under conditions of arcing due to an internal fault

A.1 General

This annex applies to CEADS of Class IAC/HV.

This classification is intended to offer a tested level of protection to persons (including operators) around CEADS in the event of internal arcs in normal operating conditions and with its HV functional unit in normal service position.

NOTE This standard covers only internal arcs occurring in the HV side of the CEADS, including HV-interconnections (e.g. between HV functional unit and HV/LV transformer functional unit). Internal arcs within the HV/LV transformer functional unit or the LV functional unit are not taken into account. (see 5.4.4 for explanation of this exclusion).

For the purpose of this annex, normal operating conditions means the conditions of a CEADS required to carry out operations such as opening or closing HV or LV switching devices, reading of measuring instruments and monitoring equipment, etc. Therefore if to perform any of such operations any cover has to be removed and/or any door has to be opened, the internal arc test shall be performed with the cover removed and/or door open. Change or replacement of HV HRC fuses is not considered as a normal operation.

Internal arcs in a CEADS can occur in a number of locations and can cause various physical phenomena. For example, the energy resulting from an arc developed in open air within the CEADS or in any insulating fluid within the enclosure of any of the HV Functional units will cause an internal overpressure and local overheating which will result in mechanical and thermal stressing of room or the enclosure (if any) containing the CEADS. Moreover, the materials involved may produce hot decomposition products, either gaseous or vaporous, which may be discharged around the CEADS.

The Internal Arc Class (IAC/HV) makes allowance for internal overpressure acting on covers, doors, floor(s) etc. It also takes into consideration the thermal effects of arc or it roots on the enclosure and of ejected hot gases and glowing particles, but not damage to internal partition and shutters not being accessible in normal operating conditions.

The internal arc tests described below are intended to verify the effectiveness of the design in protection of persons in case of an internal arc. It does not cover all effects that may constitute a hazard, such as the presence of gases with potential toxic characteristics that can be present after the fault.

Hazard of propagation of fire after an internal arc to combustible materials or equipment placed in the proximity of the CEADS is not covered by this test.

A.2 Internal arc classification

Three classes of protection in case of an internal arc are considered:

- Class A for operators;
- Class B for general public (special case of workers in a factory);
- Class AB for operators and general public.

In both classes the CEADS may have different types of accessibility on its various sides.

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For identification purposes of the different sides of the CEADS the following code shall be used:

– F for Front side;

– L for Lateral side;

– R for Rear side.

The Front side shall be clearly stated by the manufacturer.

A.2.1 CEADS classified IAC/HV-A

These CEADS meet the prescribed criteria for protection of the operators when they are performing normal operations at the operating side (or sides).

A.2.2 CEADS classified IAC/HV-B

These CEADS meet the prescribed criteria for the protection of the general public in the vicinity of the CEADS.

NOTE In the context of this standard, the workers of a factory, not in charge of the operation of the HV Switchgear, if they can approach the CEADS are considered to be general public.

To qualify for this classification, unrestricted accessibility, including that of the general public is considered to all accessible sides of the CEADS.

A.2.3 CEADS classified IAC/HV-AB

These CEADS meet the prescribed criteria for the protection of the operators when they are performing normal operations at the operating side (or sides) and the general public in the vicinity of the CEADS.

A.3 Selection of tests

To be qualified as class IAC/HV-A and/or IAC/HV-B a CEADS shall be subjected to two different test series, one on the HV functional unit and one on the HV interconnections. To be qualified as class IAC/HV-AB the CEADS shall be subjected to the test series for IAC/HV-A and IAC/HV-B.

As an exception the test on HV functional unit might be not necessary, provided that:

– this functional unit has been previously internal arc tested according to Annex A of EN 62271-200:2004, in a test arrangement equal or more onerous than the actual installation conditions in the CEADS;

– it can be proven that the other components of the CEADS do not affect the behaviour.

In case of equipment without HV functional unit and having incoming cables directly connected to the bushings of the HV/LV transformer functional unit, testing shall be carried out as follows:

– a three phase test in case of open air connections;

– a single or two phase test according to A.5.2.1 of EN 62271-200:2004 or EN 62271-201:2006 in case of plug in insulated connections.

In case that fuse-base devices are used as the only HV functional unit, a three phase test shall be performed at the feeding side of the fuse-bases.

The test procedures and the number of tests on the interconnections depend on the type of transformer protection in the switchgear and type of interconnections. Figure A.4 shows the principles for selection of tests to be performed.

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A.4 Test arrangements

A.4.1 General

The following points shall be observed:

- tests shall be carried out on a CEADS not previously subjected to arcing, or, if subjected, being in a condition which does not affect the result of the test;
- the CEADS shall be fully equipped, including HV interconnection. Mock-ups of internal components that will not be submitted to the arc are permitted provided they have the same volume and external material as the original components;
- when the CEADS is connected to earth, it shall be at the point provided.

A.4.2 Room simulation

a) CEADS designed for indoor installation. The test will be carried out in a simulated room following the principles described in A.3.2 a) of EN 62271-200:2004 or EN 62271-201:2006.

b) CEADS designed for outdoor installation. In that case no room simulation around the CEADS is required for internal arc tests aimed to verify the degree of protection provided outside the equipment. However, where the ground around the CEADS is suspected to contribute to the performance of the CEADS, simulation to the ground surface might be required.

In all cases, if the manufacturer claims that the design of the CEADS requires that the cable access way and/or any other additional exhausting duct need to be used to evacuate gases generated during the internal arc. The installation conditions specified by the manufacturer shall be reproduced, and in particular all the means, if any, to direct and cool the hot gases exhausted from the HV functional unit".

This requirement shall be clearly stated, in particular in the Instruction Manual (see Clause 10), for IAC/HV classification to be valid.

A.4.3 Indicators (for assessing the thermal effects of the gases)

A.4.3.1 General

Indicators are pieces of black cotton cloth and shall be so arranged that their cut edges do not point toward the test specimen.

Black cretonne (cotton fabric approximately 150 g/m²) shall be used for indicators for Accessibility Type A. Black cotton-interlining lawn (approximately 40 g/m²) shall be used for indicators for Accessibility Type B.

Care shall be taken to ensure that the vertical indicators cannot ignite each other. This is achieved by fitting them in a frame of sheet steel, with a depth of 2 x 30 mm ($^{+0}_{-3}$ mm), refer to Figure A.1.

With the horizontal indicators care shall be taken that glowing particles do not accumulate. This is achieved if the indicators are mounted without a frame, refer to Figure A.2.

The indicator dimensions shall be 150 mm x 150 mm ($^{+15}_{-0}$ mm).

A.4.3.2 Arrangement of indicators

Indicators shall be fitted vertically at all accessible sides of the CEADS, facing all points where gas is likely to be emitted (e.g. joints, inspection windows, doors) up to 2 m above the ground level in a checkerboard pattern covering 40 % – 50 % of the area.

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The length of the mounting rack shall be larger than the corresponding area to be tested to take into account the possibility of hot gases escaping at angles of up to 45º, from the surface under test. This means that the mounting frame shall be 100 mm longer in both sides than the specimen under test in case of accessibility Type B, or 300 mm in both sides in case of accessibility Type A, provided that the test arrangement does not limit this extension.

NOTE 1 In all cases the distance from the indicators fitted vertically to the test specimen is measured from a virtual surface that envelop the specimen , disregarding protruding elements (e.g. handles, frame of apparatus and so on). Taking into account that this virtual surface will be likely not regular, the indicators should be placed to simulate as realistically as possible the position that an operator or person usually may adopt in front of the equipment, at above indicated distance, according to type of accessibility.

a) Test to prove the level of protection to operators. Accessibility Type A (restricted accessibility)

When performing the internal arc test within the HV functional unit (See Figure A.3 a)), arrangement of indicators shall follow the requirements of Annex A of EN 62271-200:2004 or EN 62271-201:2006 for accessibility Type A.

When performing the internal arc test on HV interconnection (See Figure A.3 a)) the indicators shall be located at any accessible side, at 300 mm from the closest position the operator can reach in normal operating conditions.

NOTE 2 Normally some kind of barrier or obstacle should provide an “out of reach” condition with respect to an open-air conductor or connector.

Indicators shall also be arranged horizontally at a height of 2 m above the ground level as described in Figure A.3 a) and covering the whole area between 300 mm and 800 mm from the CEADS. The indicators shall be evenly distributed, arranged in a checkerboard pattern, covering 40 % – 50 % of the area.

b) Test to prove level of protection to general public. Accessibility Type B (unrestricted accessibility)

Indicators shall be fitted vertically at all accessible sides of the CEADS up to 2 m above the ground level. If the actual height of CEADS is lower than 1,9 m, vertical indicators shall be fitted up to a height 100 mm higher than the test specimen (See Figure A.3 b)).

The indicators shall be evenly distributed, arranged in a checkerboard pattern, covering 40 % – 50 % of the area.

The distance from the indicators to the CEADS shall be 100 mm ± 5 mm.

If the CEADS is higher than 2 m, indicators shall also be arranged horizontally at a height above the ground level as described in Figure A.3 b), and covering the whole area between 100 mm and 800 mm from CEADS.

If the CEADS is lower than 2 m, indicators shall be placed instead, in a checkerboard pattern, above the equipment, if accessible, at a distance of 100 mm ±5 mm. For CEADS lower than 800 mm, the entire upper surface shall be covered.

A.5 Point of initiation of arc

The internal arc tests covering the case of a fault inside the HV functional unit shall be performed according to Annex A of EN 62271-200:2004 for metal enclosed switchgear class IAC/HV, including the point of initiation of the arc.

The tests covering the case of a fault in the HV interconnection shall be performed following, as applicable, the provisions of Annex A of EN 62271-200:2004 or EN 62271-201:2006.

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The point of initiation shall be located at the furthest accessible point from the supply. The feeding direction shall be in accordance with the normal expected flow of the energy in service.

A.6 Current and voltage applied

Clause A.4 of EN 62271-200:2004 or EN 62271-201:2006 is applicable.

A.7 Test procedure

Clause A.5 of EN 62271-200:2004 or EN 62271-201:2006 is applicable.

A.8 Acceptance criteria

A.8.1 CEADS Class IAC/HV

A CEADS is qualified as class IAC/HV (according to the relevant accessibility type) providing that:

– the five criteria as in Clause A.6 of EN 62271-200:2004 or EN 62271-201:2006 have been met after the internal arc test on the HV functional unit,

NOTE Where the design of the CEADS includes a space below the floor to receive the exhausting gases, the behaviour of the floor should be assessed from the point of view of the safety of the operator standing on it.

– where applicable (see Figure A.4), the following criteria have been met after test on the HV interconnections:

Criterion no.1 Barriers, obstacles or enclosures of the interconnection, if any, are not moved or deformed further than the position of the indicators.

Criterion no.2 No material projections of an individual mass above 60 g.

Criterion no.3 Arcing does not cause holes in the accessible side of the enclosure of the interconnection, if this side is completely closed.

Criterion no.4 Indicators do not ignite due to the effect of flames or hot gases.

Should they start to burn during the test, the assessment criterion may be regarded as having been met, if proof is established of the fact that glowing particles rather than hot gases caused the ignition. Pictures taken by high-speed cameras, video or any other suitable means can be used by the test laboratory to establish evidence.

Indicators ignited as a result of paint or stickers burning are also excluded.

Criterion no.5 If the interconnection is protected by an enclosure connected to earth, this enclosure remains connected to its earthing point.

A.9 Test report

The following information shall be given in the test report:

– rating and description of the CEADS with a drawing showing the main dimensions, details relevant to the mechanical strength, the arrangement of the pressure relief flaps and the method of fixing the CEADS to the floor and/or to the walls;

– arrangement of the test connections;

– point and method of initiation of the internal arc;

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- drawings of test arrangement (room simulation, test specimen and mounting frame of indicators) with respect to the type of accessibility (A or B), side (F, L or R) and installation conditions;
- applied voltage and frequency;
- for the prospective or test current:
  a) r.m.s. value of the AC component during the first three half cycles;
  b) highest peak value;
  c) average value of the AC component over the actual duration of the test;
  d) test duration;
- oscillogram(s) showing currents and voltages;
- assessment of the test results, including a record of the observations in accordance with Clause A.8;
- photographs of the specimen under test, before and after test;
- other relevant remarks;
- arrangement of cable ducts if used to exhaust gases.

A.10 Designation of the internal arc classification

In case that class IAC/HV-A, IAC/HV-B or IAC/HV-AB is proven by the tests, according to 6.8, the CEADS will be designated as follows:

- general: class IAC/HV (initials of internal arc classified at the HV side);
- class A if protection to operator is proven;
- class B if protection to public is proven;
- class AB if protection of both operators and public is proven;
- F, L, R: accessible sides;
- test ratings: r.m.s. value of the test current in kA, and duration in second(s).

EXAMPLE 1
A CEADS tested for a fault current (r.m.s.) of 16 kA for 0,5 s tested for protection to operators (A.2.1) accessible at all sides.

Designation: Class IAC/HV-AFLR – 16 kA – 0,5 s.

EXAMPLE 2
A CEADS tested for a fault current (r.m.s.) of 12,5 kA for 1 s tested for protection to general public (A.2.2), accessible only at front side.

Designation: Class IAC/HV-BF- 12,5 kA – 1 s.

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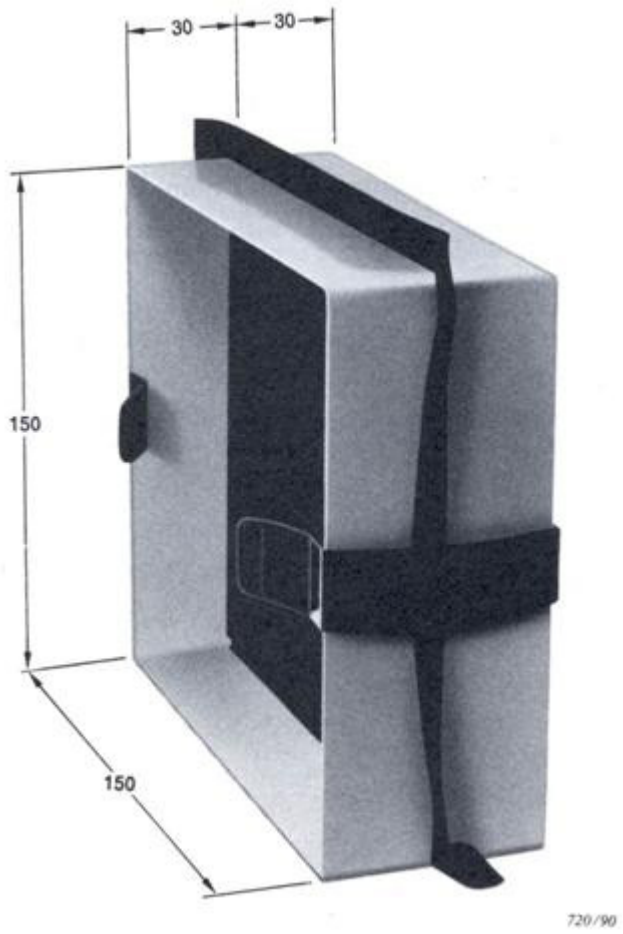


Figure A.1 – Mounting frame for vertical indicators

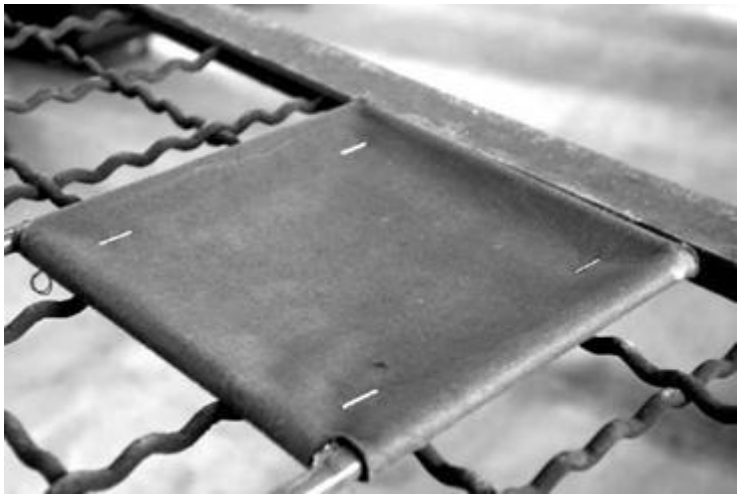
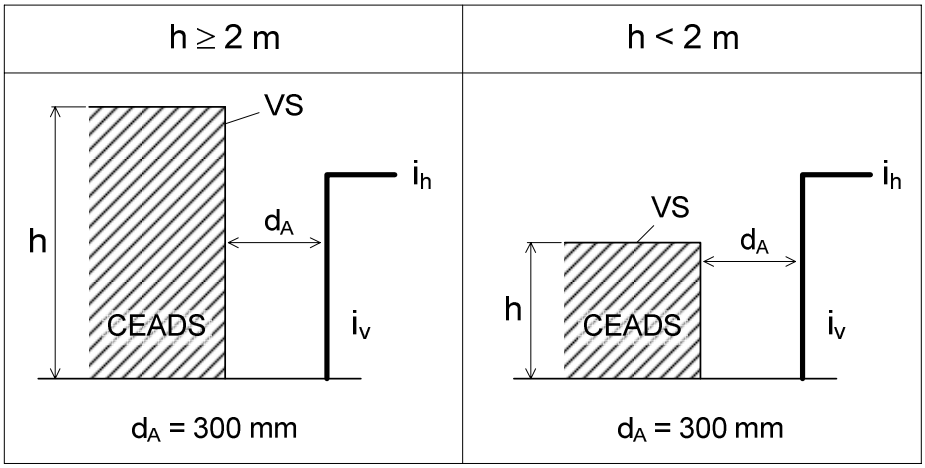
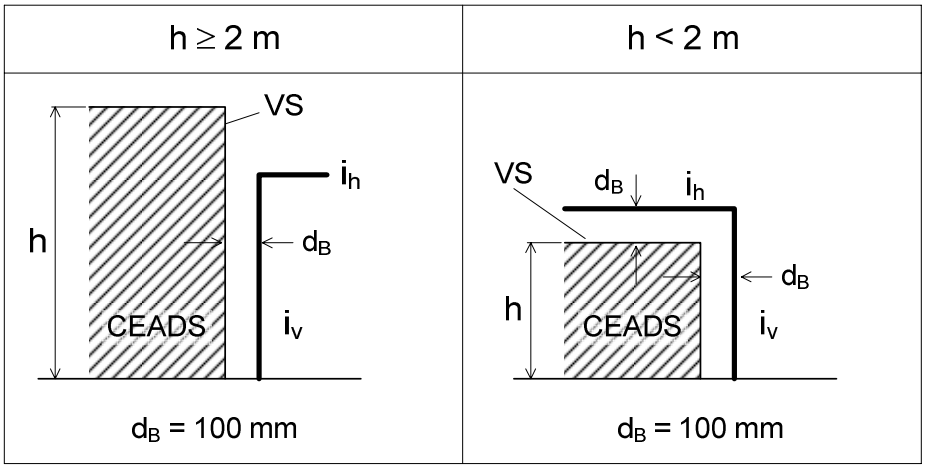


Figure A.2 – Horizontal indicators



a) Protection of operators in front of the operating side of CEADS



b) Protection of general public around the CEADS

where

i_h is the position of horizontal indicators;

i_v is the position of vertical indicators;

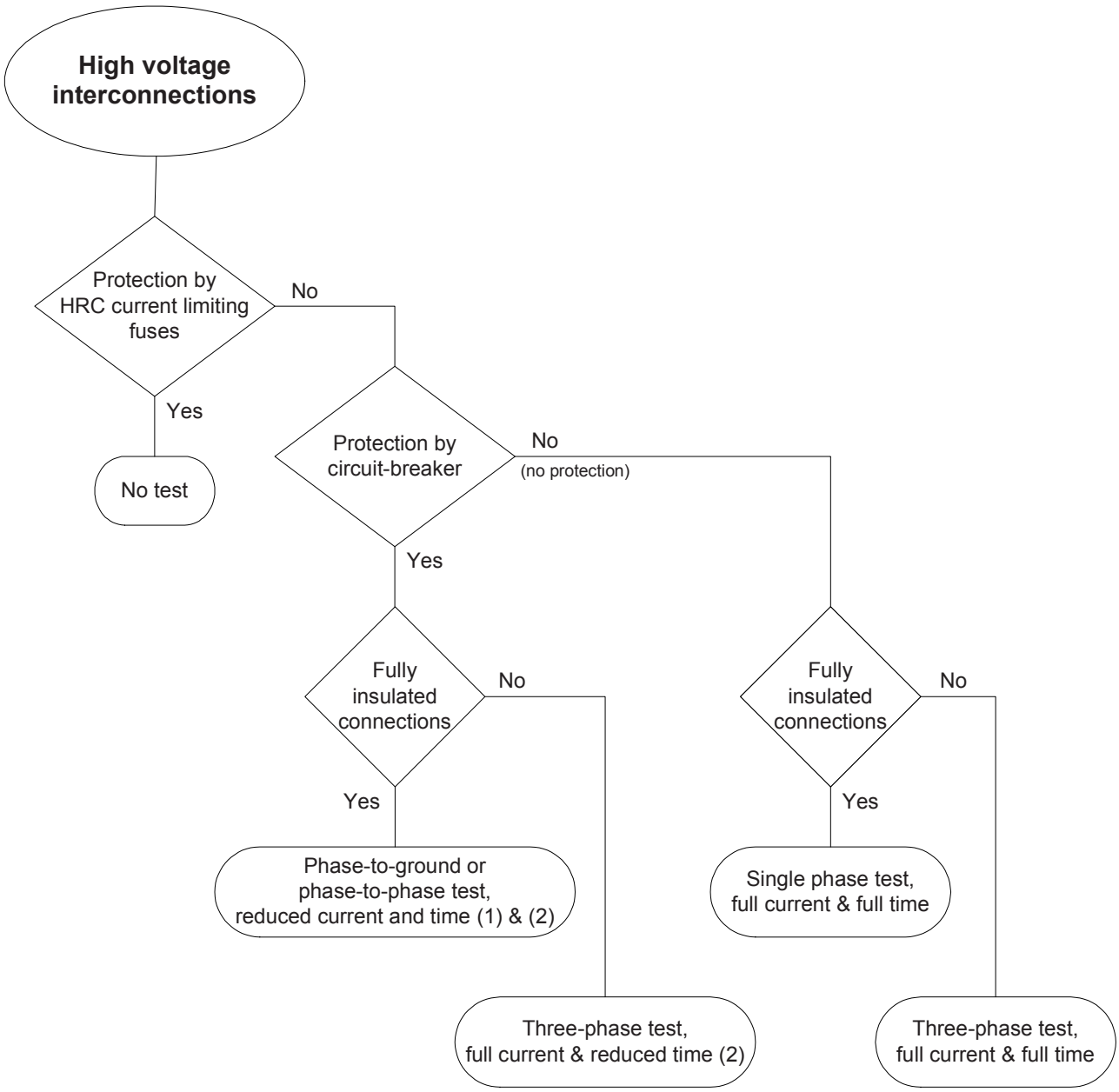
h is the height of the prefabricated CEADS;

d_A is the horizontal distance of indicators to the CEADS (operating sides);

d_B is the horizontal distance of indicators to CEADS;

VS is the virtual surface that envelopes the CEADS.

Figure A.3 – Arrangement of indicators



(1) Applicability of phase-to-ground or phase-to-phase test according to the criteria in A.5.2.1 of IEC 62271-200.
* For phase to ground test the current value to be stated by the manufacturer.
* For phase to phase test the current will be 0.87% of the rated short-time withstand current..

(2) The time may be stated by the manufacturers, taking into account the time-setting of the protection.

Figure A.4 – Selection of tests on HV interconnections for class IAC/HV

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Annex B
(normative)

Test to verify the sound level of a CEADS

B.1 Purpose

The purpose of the test is to measure the sound level of a given CEADS in full load condition. It is expected that the HV/LV transformer functional unit will be the main source of sound. However, even in the case that the HV/LV transformer functional unit is manufactured as an individual transformer according to EN 60076 series, the test could be considered relevant as the other components of the CEADS might modify the sound level of the transformer or significantly increase it by resonance phenomena.

The test values are only valid for the tested assembly at the rated operating voltage and frequency.

B.2 Test specimen

The HV/LV transformer functional unit used for test shall be of maximum rated power and losses for which the CEADS is rated.

The CEADS tested shall be fully assembled, comprising all fittings and equipment.

B.3 Test method

The test shall be carried out according to EN 60076-10. EN 60076-10 defines the method of test and calculation of an A-weighted sound level along a prescribed contour around the transformer.

The same method shall be used for measurements on the CEADS where a virtual surface that envelops the assembly (excluding protruding elements, e.g. handles) is considered to be the sound-emitting boundary. The method of measurement shall comply with 5.2.1 of EN 60076-10 with the exception of the requirement for the measuring device, which shall be at 1,5 m above ground level as defined for the CEADS.

B.4 Measurements

These shall be in accordance with 5.2.1 of EN 60076-10. For the purpose of positioning the measuring instruments, virtual surface defined in Clause B.3 shall be considered as principal radiating surface of the CEADS.

B.5 Presentation and calculation of the results

The sound level shall be calculated in accordance with Clause 6 of EN 60076-10.

The report of the test shall include all applicable information as given in Clause 7 of EN 60076-10. In addition, for the CEADS, the following information shall also be included:

c) main design characteristics of the assembly, including materials used;

d) dimensional drawing of the internal arrangement of the components inside CEADS and any other part that may significantly influence the sound propagation.

NOTE If any sound measurement on any side of the CEADS differs substantially from those on the other sides, the test report should record all values to enable the user to take account of the differences when installing the CEADS.

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Annex C
(informative)

Explanation on CEADS

C.1 Background

C.1.1 Conventional HV power installations

Traditionally a HV/LV Distribution Substation has been constructed by installing the main electrical components -HV switchgear, distribution transformer(s) and the corresponding LV distribution panel(s)- within an enclosed 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.

The HV switchgear is manufactured according to EN 62271-200:2004 or EN 62271-201:2006 and consisting in several bays devoted to the operation of the HV network and the protection of the transformer or transformers. In turn the transformer or transformers are manufactured according to EN 60076 series. Finally the LV side of the substation consists in a number of LV distribution panels (typically as many as power transformers) manufactured according to EN 60439 series. All these components are interconnected once in site by cables or other suitable means. The installation should comply with EN 61936-1 (see Figure C.1). The final quality of the installation very much depends on the quality of the work carried out on site.

C.1.2 Prefabricated substations

Some years ago in the search for a more consistent and better quality, the concept of prefabricated substation was developed. EN 62271-202 covers this type of substation. This standard requires that the main electrical components (HV switchgear, transformer and LV switchgear) be 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 (see Figure C.1).

C.1.3 CEADS

For decades some electrical utility network operators have successfully used equipment arrangements allowing compact installations that could be pre-assembled, transported and finally installed on site, e.g. UDE (Unit Distribution Equipment) in UK.

More recently new types of prefabricated assemblies have been introduced in the market. These are assemblies comprising the main electrical active components of the substation and their interconnections, manufactured as a single product. The product can therefore be type tested, manufactured, routine tested in the factory, transported and then installed in an enclosed electrical operating area. The resulting substation offers a much more easily controlled final quality compared with a conventional (non prefabricated) installation (see Figure C.2). This type of prefabricated and type-tested product is covered by this standard receiving the generic name CEADS from Compact Equipment Assembly for Distribution Substation.

C.1.4 Main features of CEADS

Another main feature of CEADS is the possibility to reduce the size of the substation, an aspect that is very appreciated due to the growing difficulty to find available space for electrical installations in populated and industrial areas.

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Reduction of the size of the substation and improvement of its reliability has lead to new designs of the components and interconnections. They may deviate from existing product standard, but not in aspects that could negatively affect performance and/or safety (e.g. use of no conventional bushings in the HV/LV transformer functional unit). In the other hand the much closer proximity of the components that even can share some parts (enclosure, solid or fluid insulation…) makes 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 standard covers any additional design and construction requirements and test methods applicable to the different types of CEADS described below.

C.1.5 Application

The concept of CEADS is mainly applicable to distribution substations. However they can be used also in industrial premises.

C.2 Type of CEADS

The standard classify CEADS in three general types: grouped CEADS (CEADS-G), associated CEADS (CEADS-A) and Integrated CEADS (CEADS-I), The three types of CEADS may differ by the type of interconnections, layout and level of proximity and/or integration of the functional units, which –in some cases- include to share parts and/or dielectric medium between certain functions, etc.

C.2.1 CEADS-G

This type of CEADS is characterised by the fact that its functional units are manufactured as independent products, which fully comply with their respective product standard. Different layout can be used (see a non comprehensive example in Figure C.3) but in all cases the functional units are placed in proximity but not attached to each other. Interconnections between functional units are of conventional type (cables or bus-bar arrangements).

C.2.2 CEADS-A

In this type of CEADS some functional unit(s) may be modified to achieve more direct interconnection between them or reduce the size of the assembly. Non conventional interfaces between the functional units may be part of the design. It may require that the functional units deviate, to some extent, from their product standard (e.g. the bushings of the transformer may be different from those mentioned in the relevant standard, or the order of phases can be modified). The functional units are manufactured as independent products, or may share part of their respective enclosures (see a non comprehensive example in Figure C.4). However none of these special features are acceptable if they affect negatively the performance, functionality and safety of the product.

C.2.3 CEADS-I

This type of CEADS is characterised by the integration of HV switchgear (totally or partially) and power transformer within a single enclosure, requiring sharing the insulating medium as well (see a non comprehensive example in Figure C.5).

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C.3 Installation of a HV/LV substation

A typical HV/LV distribution substation is, in practice, an assembly of equipment performing four basic functions:

- operation of the HV network;
- protection of the power transformer;
- HV/LV transformation;
- protection of the outgoing LV circuits.

The installation of all pieces of equipment performing the above mentioned functions, may be seen as a progressive process of integration of components. This process can be used to explain the “raison d’être” of CEADS.

To this aim we will describe two different processes for installation:

- conventional;
- using CEADS.

C.3.1 Conventional process

Figure C.1 describes what we can name the typical “flow chart” of the conventional progressive integration process to erect a HV/LV distribution substation, from single apparatus to the complete assembly.

In a first step single apparatus are used to manufacture the first level of integration to constitute the main components of the substations:

- HV switchgear, which commonly contains both functions, the operation of the network and the protection of the power transformer(s);
- power transformer(s);
- LV panel with the protection of LV outgoing circuits.

The second step of the process is the installation of these components and their interconnections within an enclosed operating area to constitute the substation. This step can be carried out in two different ways.

a) The enclosed operating area is a dedicated room in a building no necessarily intended for electrical use (e.g. in an apartment block) or a building specifically built up on site to contain the HV/LV equipment.

   In this case the three main components are transported to the site, and installed and duly interconnected in site, following requirements of EN 61936-1.

b) The enclosed operating area is a prefabricated enclosure where the main components are installed and interconnected in the factory. The assembly, including the enclosure, is designed, type tested manufactured and routine tested according to EN 62271-202.

   Then, the complete assembly is transported and placed in the installation site. No further additional internal installation works and interconnections are necessary on site.

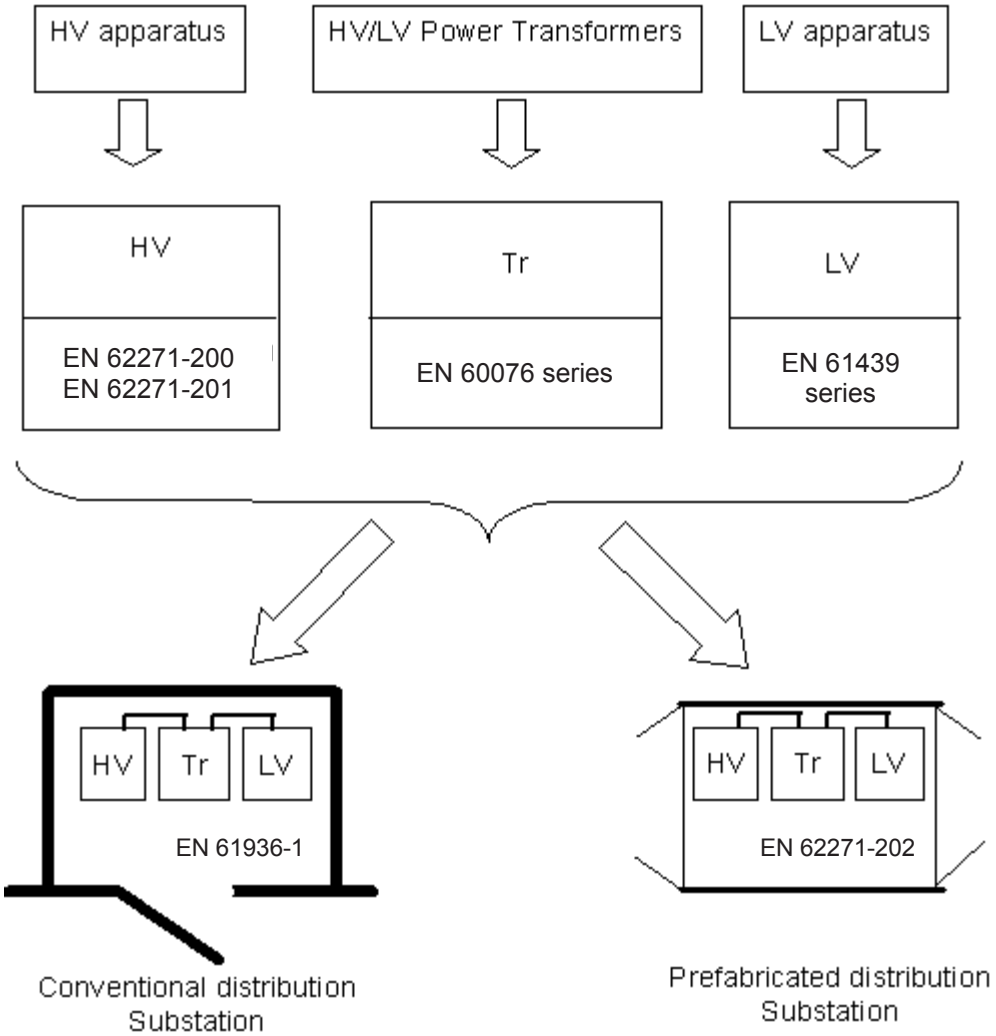

Figure C.1 – Flow chart from single apparatus to substations (conventional and prefabricated) using HV enclosed switchgear

C.3.2 Process using CEADS

Figure C.2, below, describes the same process of erection of a HV/LV distribution substation when CEADS are used.

In the “flow chart” can be seen that CEADS is – in fact – an intermediate step between the two steps described in C.3.1. The equipment that will become the main component of the substation is – in this case – pre-assembled in the factory.

The specific layout of the “pre-assembly” should be designed, type tested manufactured and routine tested according to the requirements of this standard.

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Once manufactured, the CEADS (any of the different types) is ready to follow to the final step of the erection of the substation by

– transporting it to the site and install it into the operating room. No additional internal installation works and interconnection are necessary there, except for special cases where the CEADS is delivered in several units due to transport and site access constraints, by agreement between the manufacturer and the user.

– introducing it into a prefabricated enclosure in the factory and then the complete assembly been transported to the installation site.

Concerning this second way of using CEADS, the declared goal of this standard is to go further and introduce CEADS as an alternative to manufacture prefabricated substations. This will require a future, simple, revision of EN 62271-202.

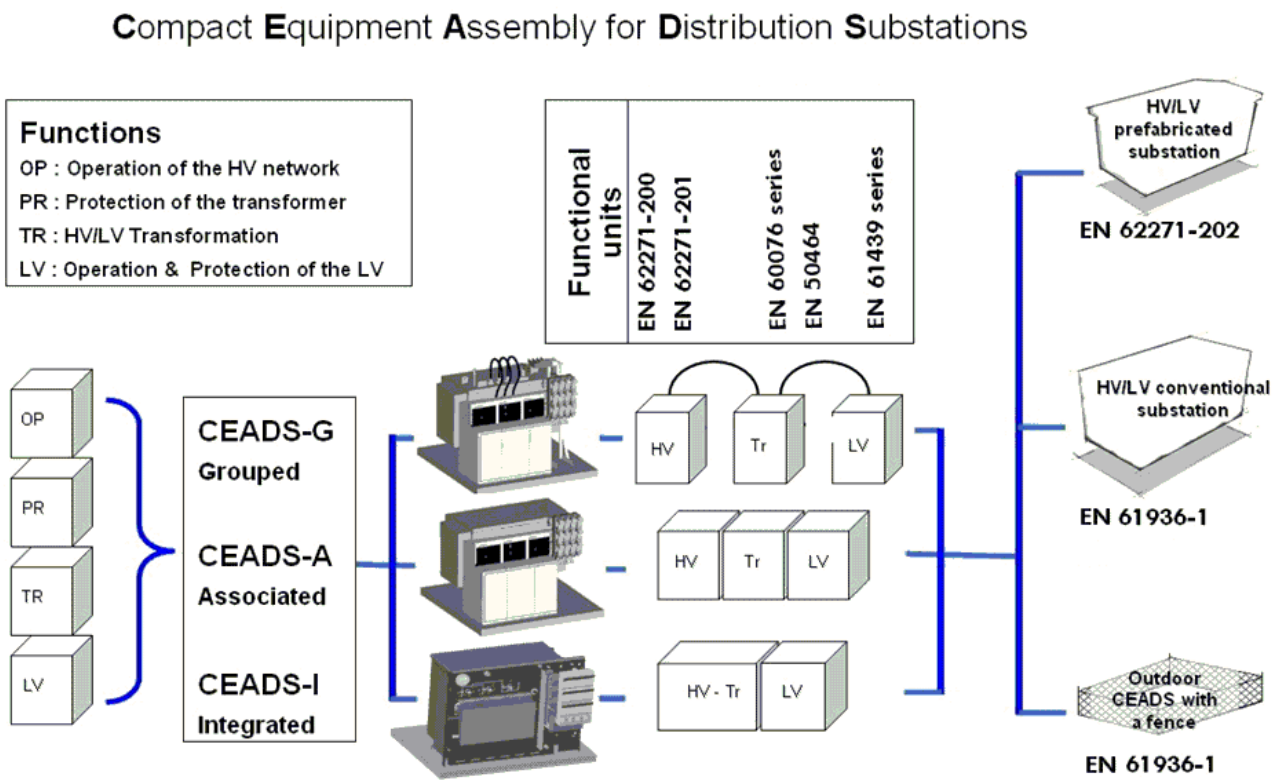

Figure C.2 – Equipment assemblies for distribution substations

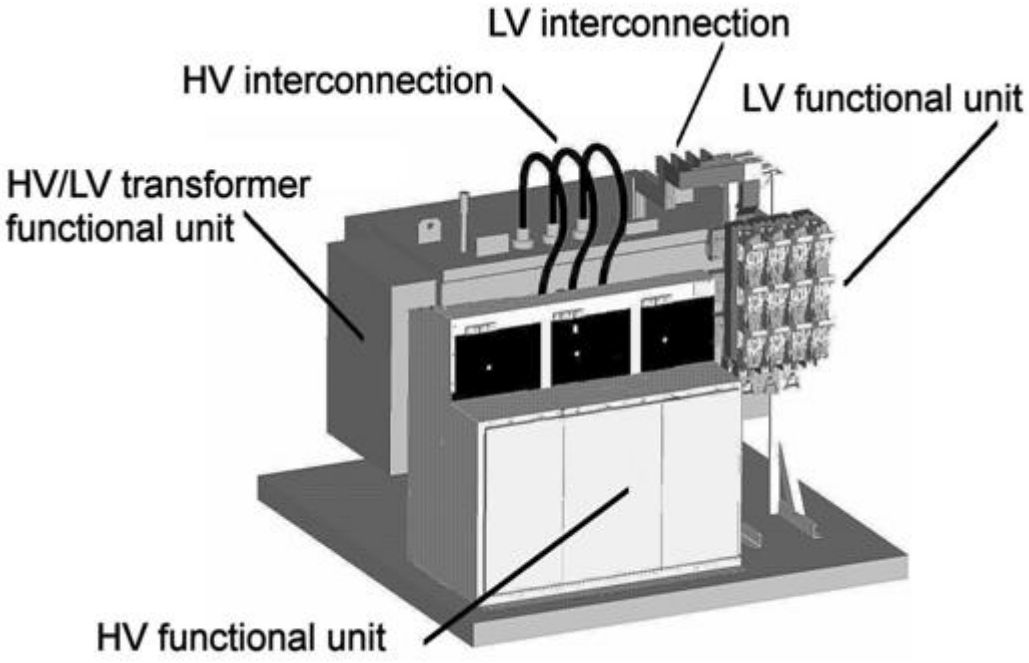

Figure C.3 – CEADS Type G

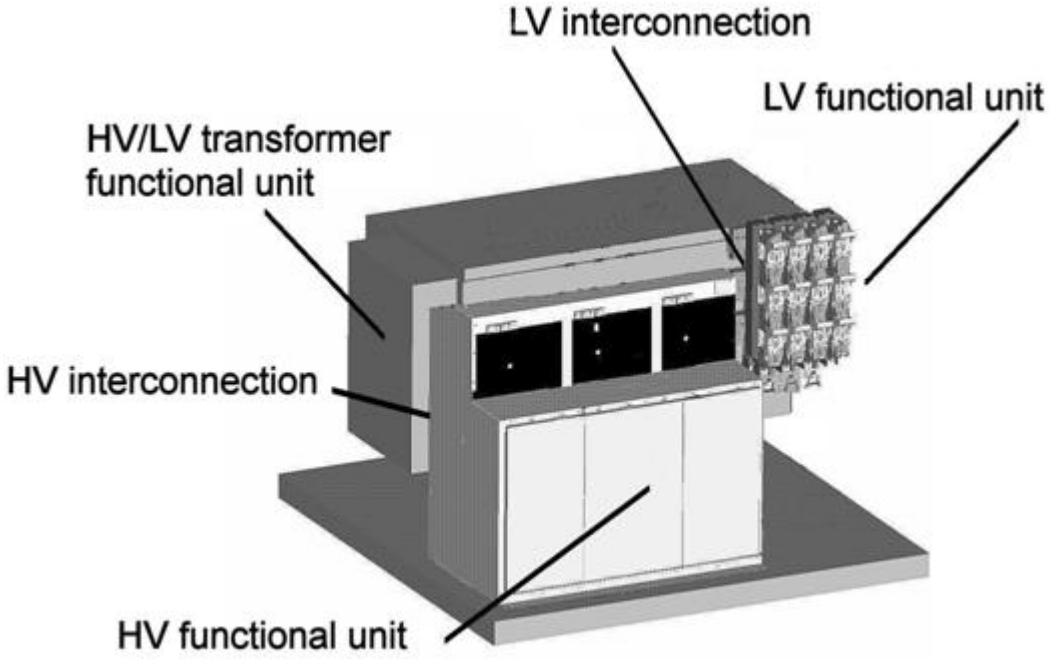

Figure C.4 – CEADS Type A

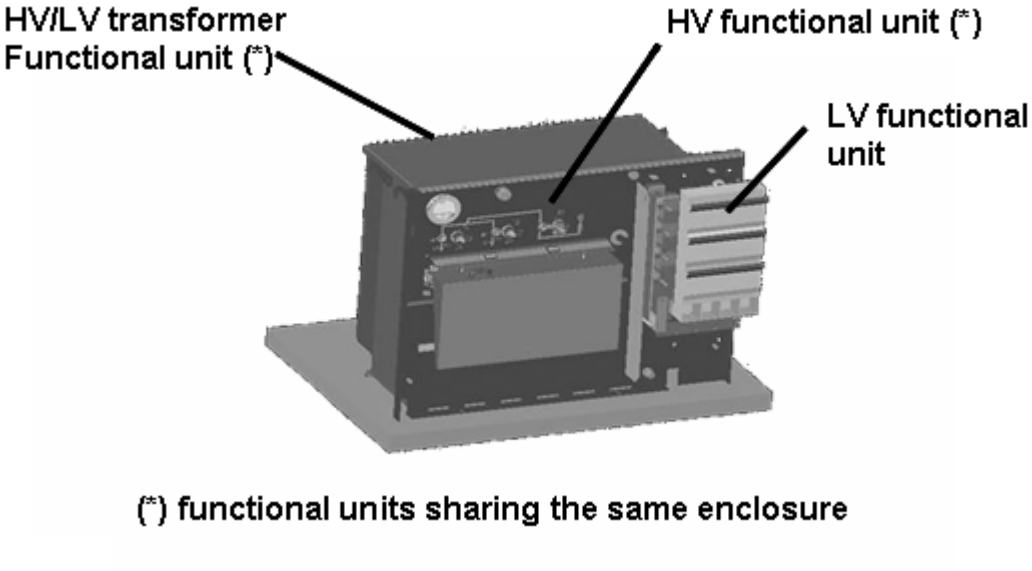

Figure C.5 – CEADS Type I

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