BRITISH STANDARD

BS 7821-1:
1995

Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV —

Part 1: General requirements and requirements for transformers with highest voltage for equipment not exceeding 24 kV —

(Implementation of CENELEC HD 428.1 S1)

UDC 621.314.212:621.3.025.3.026.645/.647

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PEL/14, Power transformers, upon which the following bodies were represented:

Association of Consulting Engineers
BEAMA Ltd. (Transmission and Distribution Association)
British Cable Makers Confederation
British Pump Manufacturers' Association
British Railways Board
Electricity Association
Institution of Plant Engineers
Transmission and Distribution Association (BEAMA Ltd.)

This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 September 1995

The following BSI references relate to the work on this standard:
Committee reference PEL/14
Draft for comment 92/29073 DC

ISBN 0 580 24551 9

Amendments issued since publication

Amd. No.	Date	Comments

Contents

National foreword

This British Standard has been prepared by Technical Committee PEL/14 and implements HD 484.1 S1:1992, published by the European Committee for Electrotechnical Standardization (CENELEC).

Cross-references

Publication referred to	Corresponding British Standard
	BS 171 *Power transformers*
HD 398.1:1980	Part 1:1978 *General*
HD 398.3:1986	Part 3:1987 *Specification for insulation levels and dielectric tests*
HD 472:1989	BS 7697:1993 *Nominal voltages for low voltage public electricity supply systems*
IEC 354:1991	BS 7735:1994 *Guide to loading of oil-immersed power transformers*

The Technical Committee has reviewed the provisions of IEC 616:1978 to which normative reference is made in the text, and has decided that it is acceptable for use in conjunction with this standard.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the HD title page, pages 2 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

HARMONIZATION DOCUMENT

DOCUMENT D'HARMONISATION

HARMONISIERUNGSDOKUMENT

HD 428.1 S1

November 1992

UDC 621.314.212:621.3.025.3.026.645/.647

Supersedes HD 428.1 S1:1983 + A1:1990

Descriptors: Distribution transformers, electrical characteristics, dimensions, impedance voltage, losses, rollers, sound levels

English version

Three phase oil-immersed distribution transformers, 50 Hz, from 50 to 2 500 kVA with highest voltage for equipment not exceeding 36 kV
Part 1: General requirements and requirements for transformers with highest voltage for equipment not exceeding 24 kV

Transformateurs triphasés de distribution immergés dans l'huile, 50 Hz, de 50 à 2 500 kVA, de tension la plus élevée pour le matériel ne dépassant pas 36 kV
Partie 1: Prescriptions générales et prescriptions pour les transformateurs avec une tension la plus élevée pour le matériel ne dépassant pas 24 kV

Drehstromverteilungstransformatoren der Energieversorgung, mit Olfüllung, 50 Hz, 50 — 2 500 kVA, mit einer höchsten Spannung für Betriebsmittel kleiner oder gleich 36 kV
Teil 1: Allgemeine Anforderungen und Anforderungen für Transformatoren mit einer höchsten Spannung für Betriebsmittel kleiner oder gleich 24 kV

This Harmonization Document was approved by CENELEC on 1992-09-15. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for implementation of this Harmonization Document on a national level.

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

This Harmonization Document exists in three official versions (English, French, German).

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CENELEC

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

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

This Harmonization Document was prepared by working group WG 3 of CENELEC Technical Committee TC 14, Power transformers.

It was approved by CENELEC as HD 428.1 S1 on 15 September 1992.

This Harmonization Document replaces HD 428 S1:1983 and its amendment A1:1990.

The following dates were fixed:

- latest date of announcement of the HD at national level (doa) 1993-03-01
- latest date of publication of an identical national standard (dop) 1993-09-01
- latest date of withdrawal of conflicting national standards (dow) 1993-09-01

Annexes designated "normative" are part of the body of the standard. Annexes designated "informative" are given only for information. In this standard, Annex A (A-deviations) is informative and Annex B (normative references) is normative.

Statement

This document has been prepared to allow a standardized production in series of units and to favour the interchange of products within the CENELEC countries and, if applicable, with other countries.

Every standard prepared by National Committees shall be in line with this CENELEC document, as far as the specific field of application is concerned.

This document comes into use as and when indicated in the tender and contractual documents.

When for special applications particular characteristics are required outside the standard features, the transformers can be specified and ordered individually in accordance with HD 398.

1 General

1.1 Scope

This harmonization document covers transformers from 50 to 2 500 kVA intended for operation in three-phase distribution networks, for indoor or outdoor continuous service, 50 Hz, immersed in mineral-oil, natural cooling, with two windings:

— a primary (high-voltage) winding with a highest voltage for equipment from 3,6 to 24 kV,

— a secondary (low-voltage) winding with a highest voltage for equipment not exceeding 1,1 kV.

NOTE 1 This document may be applied, either as a whole or in part, to transformers immersed in a synthetic insulating liquid.

NOTE 2 This document may be applied, either as whole or in part, to transformers having windings with more than one rated voltage. In this case the rated power for each rated voltage shall be specified by the purchaser.

NOTE 3 Oil-immersed transformers with other highest voltages for equipment could be matter of other parts of HD 428 series.

1.2 Object

The object of this document is to lay down requirements related to electrical characteristics, dimensions and design. Other requirements may be specified in a National Standard.

1.3 Compliance with current harmonization documents

Transformers shall be in accordance with harmonization documents of the HD 398 series.

2 Electrical characteristics

2.1 Rated power

The values of the rated power are:

<u>50</u> – 63 – <u>100</u> – <u>160</u> – 200 – <u>250</u> – 315 – <u>400</u> – 500 – <u>630</u> – 800 – <u>1 000</u> – 1 250 – <u>1 600</u> – 2 000 – <u>2 500</u> kVA.

The underlined values are preferred.

National. Standards may include also a number of non-preferred values among those mentioned above, including 25 kVA.

2.2 Highest voltages for equipment of windings

The values of the highest voltage for equipment are:

a) For the high-voltage winding:

3,6 – 7,2 – 12 – 17,5 – 24 kV

b) For the low-voltage winding:

1,1 kV

2.3 Rated voltages of windings

a) For the high-voltage winding:

The preferred ranges of values of the rated voltage U_r are related to the values of the highest voltage for equipment U_m as stated in Table I.

b) For the low-voltage winding:

The rated voltage shall be chosen from the following values:

400 – 410 – 420 – 433 V.

NOTE 1 According to HD 472 S1, the nominal voltages for low-voltage distribution systems shall evolve towards 400 V.

NOTE 2 Rated voltage 410 V is suitable for new transformers in the intermediary steps of bringing low-voltage systems, originally at 380 V, within the range 400 V $^{+6}_{-10}$ %.

NOTE 3 This document may be applied, either as a whole or in part, to transformers with rated voltages below 400 V and above 433 V.

Table I

U_m (kV)	3,6	7,2	12	17,5	24
U_r (kV)	3 to 3,3	5 to 6,6	10 to 11,5	12 to 16	20 to 22

2.4 Tappings

The high voltage winding is normally provided with tappings corresponding to a tapping range of ± 2,5 % or ± 2 × 2,5 % or + 2 × 2,5 % – 3 × 2,5 %, to be specified by the purchaser. These tappings are connected to an off-circuit tap-changer.

Upon special agreement between purchaser and manufacturer, internal reconnecting links can be used as an alternative.

2.5 Connections

Connections shall be:

— for rated power below 250 kVA:

Yzn or Dyn

— for rated power of 250 kVA and above:

Dyn

The clock hour figure shall be 5 or 11.

Connections and clock figure shall be specified by the purchaser.

NOTE This document may be applied, either as a whole or in part, to transformers having connections other than those mentioned above.

2.6 Dimensioning of neutral connection of the low-voltage winding

The neutral conductor and terminal of the low-voltage winding shall be dimensioned for rated current and earth fault current, unless otherwise specified.

2.7 Short-circuit impedance

The preferred values of the short-circuit impedance at a reference temperature of 75 °C are:

— below 630 kVA: 4 %

— for 630 kVA: 4 % or 6 %

— above 630 kVA: 6 %

NOTE Other values of short-circuit impedance may be specified by the purchaser for particular system service conditions, e.g. in the case of parallel operation.

2.8 Losses and sound power level

For transformers having preferred values of rated power and short-circuit impedance in accordance with subclauses **2.1** and **2.7**, the values of losses and sound power levels are stated in Table II (load losses) and Table III (no-load losses and sound power levels).

Table II

Rated Power kVA	**List A P_k** W	**List B P_k** W	**List C P_k** W	**Short-circuit impedance** %
50	1 100	1 350	875	
100	1 750	2 150	1 475	
160	2 350	3 100	2 000	4
250	3 250	4 200	2 750	
400	4 600	6 000	3 850	
630	6 500	8 400	5 400	
630	6 750	8 700	5 600	
1 000	10 500	13 000	9 500	
1 600	17 000	20 000	14 000	6
2 500	36 500	32 000	22 000	
P_k = load loss				

Table III

Rated power	List A′		List B′		List C′		Short-Circuit impedance
kVA	P_O W	L_{WA} dB	P_O W	L_{WA} dB	P_O W	L_{WA} dB	%
50	190	55	145	50	125	47	
100	320	59	260	54	210	49	
160	460	62	375	57	300	52	4
250	650	65	530	60	425	55	
400	930	68	750	63	610	58	
630	1 300	70	1 030	65	860	60	
630	1 200	70	940	65	800	60	
1 000	1 700	73	1 400	68	1 100	63	
1 600	2 600	76	2 200	71	1 700	66	6
2 500	3 800	81	3 200	76	2 500	71	

P_O = no-load loss

L_{WA} = sound power level

With respect to the listed loss values, deviations in the range of ± 5 % are admitted in National Standards. For list C, the admitted deviation is extended to ± 7.5 %.

NOTE For list C larger deviations, but not exceeding ± 10 %, are admitted only as temporary national deviations.

The preferred coupling values should be those of the following list combinations:

A – A′ , B – B′ , C – B′ , A – C′ , C – C′

In National Standards one or more of the above combinations of losses taken from Table II and Table III (including the admitted deviations), are allowed.

The losses for transformers having rated power included among the non-preferred values (subclause **2.1**) should be obtained by interpolation.

The sound power levels given in Table III are the maximum admitted (no tolerance). Lower sound power levels can be specified by the purchaser.

When the loss values stated in the above Table II and Table III do not correspond to the actual evaluation of the energy cost, or in case of established practice in the market, or in case of special feature, the transformers can be requested and, by consequence, offered, with losses differing from the tabled losses.

In such a case, a formula for capitalization of losses shall stated in the request.

The formula should be of the following type:

$$C_C = C_T + AP_o + BP_k$$

where:

C_C = Capitalized cost

C_T = Tendered price

A = Value indicated by the purchaser in tender invitation expressed in monetary value per watt corresponding to no-load loss

P_o = Guaranteed no-load loss in watts

B = Value indicated by the purchaser in tender invitation expressed in monetary value per watt corresponding to load loss

P_k = Guaranteed load loss in watts

Other terms may be introduced by a National Committee or by a purchaser in the formula, to take into acount other technical and financial aspects.

Within the limits of tolerances (HD 398.1), the application of penalties/bonus with regard to losses is left to the agreement between manufacturer and purchaser at the time of enquiry and order.

2.9 Insulation levels and dielectric tests

Insulation levels and dielectric tests shall be in accordance with the requirements of HD 398.3, as further detailed below:

a) High-voltage winding:

The rated values of the short duration Power frequency withstand voltage and of the lightning impulse withstand voltage are given by Table II of HD 398.3, list 2 being used for the lightning impulse withstand voltage.

However, in accordance with the note of subclause **5.2** of HD 398.3[1)], higher test voltages or additional tests may be required.

b) Low-voltage winding:

According to Table II of HD 398.3, for the normal insulation level, only a short duration power frequency withstand voltage equal to 3 kV, is specified.

However, following the principle of the above-mentioned note of subclause **5.2** of HD 398.3, the short duration power frequency withstand voltage may be raised to 10 kV and/or a lightning impulse withstand test between windings and earth may be performed at 20 kV (peak value) by agreement between purchaser and manufacturer. Other values for the lightning impulse withstand test may be agreed between purchaser and manufacturer.

When an impulse test is made, the test voltage shall be applied between all low-voltage terminals connected together and tank, all high voltage terminals being connected together and earthed directly or by a resistance.

3 Design requirements

3.1 Type of oil preservation system and degree of sealing

The type of oil preservation system and the degree of sealing shall be indicated in the enquiry and order.

In the case of hermetically sealed transformers, the maximum admissible temperature of the oil shall be indicated at the time of the enquiry, and marked on the rating plate, if it is lower than the value of 115 °C stated in the IEC loading guide (IEC 354).

3.2 Terminal markings

Terminal markings should preferably be in accordance with IEC 616:1978[2)], unless otherwise specified in National Standards.

3.3 Terminations

The termination to be used can be of the following types:

a) open type bushings

b) oil-oil bushings (cf. **4.2.3**)

c) cable boxes (cf. **4.2.3**)

d) plug-in type bushings of either inside or outside cone type.

The requirements of the different types of terminations should be matter of separate harmonized document.

4 Dimensional characteristics

4.1 Rollers

When rollers are fitted:

a) The preferred values of the distance between centres are:

520, 670, 820, 1 070 mm

b) The values of diameter and width are:

— diameter 125 mm with width 40 mm or 50 mm,

— diameter 150 mm with width 50 mm,

— diameter 200 mm with width 70 mm.

4.2 Distance between bushings

4.2.1 Distances between high-voltage oil-air bushings

The preferred value of the distance between centers is 265 mm. For transformers with a highest voltage for equipment equal to 24 kV, the minimum distance between metallic parts of the heads shall be 200 mm and between the highest sheds 120 mm. However, shorter distances may be agreed, subject to confirmation by test or by service experience.

NOTE 1 If the user intends to make the connections to the transformer in a way which may reduce the clearances provided by the transformer itself, then this should be brought to attention in the enquiry. (See HD 398.3, clause **2**).

NOTE 2 When an oil-immersed transformer is specified for operation at an altitude higher than 1 000 m, clearances shall be designed accordingly. It may then be necessary to select bushings designed for higher insulation levels than those specified for the internal insulation of the transformer windings (see HD 398.3, clause **2**).

4.2.2 Preferred distance between centers of low-voltage bushings

a) For currents up to 250 A	70 mm
b) For currents above 250 A and up to 2 000 A	150 mm
c) For currents above 2 000 A	165 mm

4.2.3 Cable boxes

For transformers in which the terminations are made in cable boxes, HD 428.2[3)] applies.

[1)] This note reads "Distribution transformers for suburban or rural installations are in some countries severely exposed to overvoltages. In such cases, higher test voltages or additional tests, which are not mentioned here, may be agreed between manufacturer and purchaser".

[2)] IEC 616:1978 — *Terminal and tapping markings for power transformers (Report)*

[3)] In preparation.

5 Accessories

Transformers shall normally be fitted with the accessories listed in Table IV.

Table IV

Accessories	Free Breathing	Hermetically Sealed
Rating place	X	X
2 Earthing terminals	X	X
Lifting lugs	X	X
Oil level indicator	X	[a]
Filling hole	X	X
Drain and sampling plug or valve	X	X

[a] an equivalent device may be provided if requested by the purchaser

If specifically requested by the purchaser, additional accessories may be fitted, for instance:

— Thermometer pocket

— Jacking lugs (500 kVA above)

— Arcing horns on H.V. bushings

— Gas relay

— Provision for padlocking of the off-circuit tap-changer

— Pulling eyes.

For transformers in which the terminations are made in cables boxes, HD 428.2[4)] applies.

[4)] In preparation.

Annex A (informative)
A-deviations

A-deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CENELEC member.

This European Standard does not fall under any Directive of the EC. In the relevant CENELEC countries these A-deviations are valid instead of the provisions of the European Standard until they have been removed.

Clause	Deviation
2.9b	SWITZERLAND (SEV 4009, 1985)
	The power frequency withstand voltage is “4 kV” instead of “3 kV”.

Annex B (normative)
Normative references

This Harmonization Document incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this Harmonization Document only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

HD 398	series	*Power transformers* (IEC 76, mod)
HD 398.1	1980	*Part 1: General* (IEC 76-1:1976, mod)
HD 398.3	1986	*Part 3: Insulation levels and dielectric tests* (IEC 76-3:1980 + A1:1981, mod)
HD 428.2		(In preparation)
HD 472	1989	*Nominal voltages for low voltage public electricity supply systems* (IEC 38:1983, mod)
IEC 354	1972	*Loading guide for oil-immersed transformers*
IEC 616	1978	*Terminal and tapping markings for power transformers*
(Report)		

List of references

See national foreword.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

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