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EN 50060:
1989
Incorporating Amendment No. 1

Arc welding power sources, equipment and accessories —

Part 9: Specification for power sources for manual arc welding with limited duty

This European Standard EN 50060 has the status of a British Standard

UDC 621.791.755.037:621.311.6:620.1:614.8

Cooperating organizations

The European Committee for Standardization, under whose supervision this European Standard was prepared, comprises the national standards organizations of the following Western European countries.

Austria	Oesterreichisches Normungsinstitut
Belgium	Institut belge de normalisation
Denmark	Dansk Standardiseringsraad
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United Kingdom	British Standards Institution

The British Standard, having been prepared under the direction of the Welding Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 May 1990

The following BSI references relate to the work on this standard:
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8489	May 1995	Indicated by a sideline in the margin

Contents

National foreword

This Part of BS 638 has been prepared under the direction of the Welding Standards Policy Committee and is identical with European Standard EN 50060:1989 including amendment A1:1994.

It differs from previous Parts of BS 638 in being applicable to equipment intended, primarily, for the non-professional welding operator.

Other Parts of BS 638 are:

— *Part 1: Specification for oil cooled power sources for manual, semi-automatic and automatic metal-arc welding and for TIG welding;*

— *Part 2: Specification for air cooled power sources for manual metal-arc welding with covered electrodes and for TIG welding;*

— *Part 3: Specification for air cooled power sources for semi-automatic and automatic metal-arc welding;*

— *Part 4: Specification for welding cables;*

— *Part 5: Specification for accessories;*

— *Part 6: Specification for safety requirements for construction;*

— *Part 7: Specification for safety requirements for installation and use;*

— *Part 8: Specification for electrode holders and hand held torches and guns for MIG, MAG and TIG welding.*

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 30, 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.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 50060
February 1989
+ *A1* *August 1994*

UDC: 621.791.755.037:621.311.6:620.1:614.8

Key words: Welding equipment; safety requirements; manual arc welding; power source; construction; test methods

English version

Power sources for manual arc welding with limited duty

(include amendment A1:1994)

Source de courant pour soudage manuel à l'arc, à service limité
inclut l'amendement A1:1994

Schweiß-stromquellen zum Lichtbogenhandschweißen für begrenzten Betrieb
enthält Änderungen A1:1994

This European Standard was ratified by CENELEC on 6 December 1988. CENELEC members are bound to comply with the requirements of the CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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

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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

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Brief history

The European Standard 50060 was prepared by TC 26A of CENELEC; it was submitted to the CENELEC members for formal vote and acceptance as European Standard (EN) by CENELEC.

Technical text

The text of the European Standard 50060 was approved by all CENELEC members with exception of Austria and Finland on 6 December 1988.

The following dates were fixed:

- — date of announcement (doa) : 1989-07-01
- — date of latest publication (dop) : 1990-01-01
- — date of withdrawal of conflicting national standard (dow) : 1990-01-01

Foreword to amendment A1

This amendment to EN 50060:1989 was prepared by CENELEC Technical Committee TC 26A "Electric arc welding equipment".

It was submitted to the CENELEC members for formal vote in september 1993 and and was approved by CENELEC as amendment A1 to EN 50060:1989 on 1994-03-08.

The following dates were fixed:

- — latest date of publication of an identical national standard (dop) 1995-03-15
- — latest date of withdrawal of conflicting national standards (dow) 1995-03-15

For products which have complied with EN 50060:1989 before 1995-03-15, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2000-03-15.

Contents

Section 1. General

1 Scope

This standard is applicable to welding power sources for manual metal arc welding with limited duty with covered stick electrodes.

These welding power sources

a) are limited to a rated maximum welding current of 160A.

b) are fitted with a thermal cut-out device.

c) have performance based on the number of reference electrodes, capable of being melted with the welding power source in the cold and hot state and

d) carry on their rating plate a declaration of the fuse size necessary for the maximum output.

This standard is not applicable to rotating welding power sources or welding power sources with remote control or welding power sources incorporating frequency conversion.

NOTE Inverter type welding power sources are excluded from this standard on the grounds that

a) there are not yet available methods to test the safety of them,

b) they cause considerable harmonic distortions to the supply.

2 Object

This standard specifies safety requirements for the construction and relevant performance requirements and describes test methods to verify compliance.

3 Environmental conditions

Welding power sources shall be capable of carrying out their welding operation when the following conditions prevail:

a) Range of the temperature of the ambient air:

during welding: – 10 °C to + 40 °C.

during transport and storage: – 25 °C to + 55 °C.

NOTE The values given on the rating plate are based on 20 °C. If the ambient air temperature is higher, the duty will become less, i.e. the number of electrodes, capable of being melted from the cold state (n_c) or from the hot state (n_h) will become less.

b) Relative humidity of the air: up to 90 % at 20 °C.

c) Ambient air, free from abnormal amounts of dust, acids, corrosive gases or substances etc. other than those generated by the welding process.

4 Definitions

4.1
power source for manual metal arc welding

a power source with drooping characteristic for supplying electrical energy to the welding arc

NOTE In the following text, the term "welding power source" is used.

4.2
dual supply voltage welding power source

a welding power source which may be supplied alternatively by two different supply voltages (e.g. 220 and 380 V)

4.3
thermal cut-out device

a device, by means of which the temperature of the welding power source is limited by automatic interruption of the input or output current being reset automatically

4.4
reference electrode

an electrode of the type E 43 R according to ISO 2560, whose diameter, fusible length and welding current are given in Table III, Clause **7.1**

4.5
type test

a test of one or more devices made to a given design, to check if the design complies with the requirements of the standard concerned

4.6
routine test

a test made on each individual device during or after manufacture to check if it complies with the requirements of the standard concerned

4.7
general visual inspection

a visual inspection to verify that there are no apparent faults

4.8
conventional value

a standardized value that is used as a measure of a parameter for the purposes of comparison, calibration, testing etc.

NOTE Conventional values do not necessarily apply during the actual welding process.

4.9
rated value

a quantity value assigned, generally by the manufacturer, for a specified operating condition of a component, device or equipment

4.10
welding current

the current delivered by a welding power source during welding

4.11
drooping characteristic

an external static characteristic of a welding power source which, in its normal welding range, is such that, as the current increases, the voltage decreases by more than 7V/100A

4.12
duty

the schedule of operating conditions to which the welding power source is subjected

NOTE In this standard, the duty is expressed by the number of reference electrodes n_c (see Clause **4.30**) and n_h (see Clause **4.31**).

4.13
conventional welding condition

a condition of the welding power source in the hot state defined by a conventional welding current driven by the corresponding conventional load voltage through a conventional load at rated supply voltage and frequency

NOTE The conventional load for testing purposes replaces the arc welding electrode and the arc by a practically non-inductive constant resistive load having a power factor not less than 0.99.

4.14
no-load voltage

the voltage between the output terminals of a welding power source when the external welding circuit is open

4.15
rated no-load voltage (U_o)

the no-load voltage at rated supply voltage and frequency

4.16
load voltage

the voltage between the output terminals of a welding power source, when it is delivering current

4.17
conventional load voltage (U_2)

the load voltage of a welding power source having a specified linear relationship to the conventional welding current (see Clause **10.2**)

4.18
conventional welding current (I_2)

the current delivered by a welding power source to a conventional load at the corresponding conventional load voltage

4.19
rated maximum welding current ($I_{2\ max}$)

the maximum value of the conventional welding current that can be obtained at the conventional welding condition from a welding power source at its maximum setting

4.20
rated supply voltage (U_1)

the supply voltage for which the welding power source is constructed

4.21
rated supply current (I_1)

the supply current to the welding power source at a conventional welding condition

4.22
rated maximum supply current ($I_{1\ max}$)

the maximum value of the rated supply current

4.23 *Text deleted*

4.24
operating temperature (θ_{off})

the temperature of the welding power source windings when the thermal cut-out device operates (see Figure 1)

4.25
maximum winding temperature (θ_{max})

the maximum allowable value of the operating temperature (see Table IV)

4.26
reset temperature (θ_{on})

the temperature of the welding power source windings, when the thermal cut-out device resets (see Figure 1)

4.27
heating time from the cold state (t_c)

the time for heating up the welding power source windings from the cold state (20 ± 2) °C to the operating temperature θ_{off} at conventional welding condition (see Figure 1)

4.28
heating time from the hot state (t_h)

the time for heating up the welding power source windings from the reset temperature θ_{on} to the operating temperature θ_{off} at conventional welding condition (see Figure 1)

4.29
melting time (t_f)

the conventional time to melt one reference electrode at the conventional welding current I_2

4.30
number of reference electrodes n_c

the number of reference electrodes capable of being melted with the welding power source starting from the cold state (20 ± 2) °C without operation of the thermal cut-out device; this number is calculated by the formula given in Clause **7.1**

4.30a)
number of reference electrodes n_{c1}

the number of reference electrodes capable of being melted within the first hour with the welding power source starting from the cold state (20 ± 2) °C; this number is calculated by the formula given in **7.1**

4.31
number of reference electrodes n_h

the number of reference electrodes capable of being melted with the welding power source at the hot state starting from resetting, without operation of the thermal cut-out device; this number is calculated by the formula given in Clause **7.1**

4.31a)
number of reference electrodes n_{h1}

the number of reference electrodes capable of being melted during one hour with the welding power source at the hot state starting from resetting; this number is calculated by the formula given in **7.1**

4.32
basic insulation[1)]

insulation of live parts, the failure of which causes a risk of electric shock

4.33
supplementary insulation[1)]

independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation

4.34
double insulation[1)]

insulation comprising both basic insulation and supplementary insulation

4.35
reinforced insulation[1)]

single insulation of live parts intended to provide protection against electric shock not less than that provided by double insulation

NOTE It is not implied that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

4.36
protection Class I equipment[1)]

equipment with basic insulation between live parts and exposed conductive parts with bonding of exposed conductive parts to a means for connection of an external protective conductor

NOTE Protection Class I equipment may have parts with double or reinforced insulation.

4.37
protection Class II equipment[1)]

equipment in which the protection against indirect contact does not rely on basic insulation only, but in which additional dispositions are provided to avoid a fault between live parts and the accessible surface

4.38
clearance

the shortest distance in air between two conductive parts

NOTE For the purpose of determining a clearance to accessible parts, the accessible surface of an insulating enclosure shall be considered conductive as if it were covered by a metal foil wherever it can be touched by the standard test finger according to IEC 529.

4.39
creepage distance

the shortest distance along the surface of an insulating material between two conductive parts

NOTE For the purpose of determining a creepage distance to accessible parts, the accessible surface of an insulating enclosure shall be considered conductive as if it were covered by a metal foil wherever it can be touched by the standard test finger according to IEC 529.

NOTE to Clause **4.38** and **4.39**. Creepage distances and clearances are measured through the joint between two parts of an insulating barrier except when:

— either the two parts forming the joint are bonded together by heat sealing or other similar means at the place where this is of importance,

— or the joint is completely filled with adhesive at the necessary places and the adhesive bonds to the surfaces of the insulating barrier so that moisture cannot be absorbed into the joint,

— or the joint is sealed in such a way that it may be considered tight for the expected life of the welding power source.

4.40
pollution

any addition of foreign matter, solid, liquid, or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity

NOTE The following four degrees of pollution in the micro-environment are established:

[1)] NOTE This definition may be amended on publication of the next edition of IEC Publication 536.

4.41
pollution degree 1

no pollution or only dry, non-conductive pollution occurs. The pollution has no influence

4.42
pollution degree 2

normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected

4.43
pollution degree 3

conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected

4.44
pollution degree 4

the pollution generates persistent conductivity caused, for instance, by conductive dust or by rain or snow

4.45
micro-environment

the ambient conditions which surround the clearance or creepage distance under consideration

NOTE The micro-environment of the creepage distance or clearance and not the environment of the equipment determines the effect on the insulation. The micro-environment might be better or worse than the environment of the equipment. It includes all factors influencing the insulation, such as climatic conditions, electromagnetic effects, generation of pollution.

4.46
material group

for the purpose of IEC 664 materials are separated into four groups by their Comparative Tracking Index values, as follows:

Material Group I	$600 \leqslant \text{CTI}$
Material Group II	$400 \leqslant \text{CTI} < 600$
Material Group IIIa	$175 \leqslant \text{CTI} < 400$
Material Group IIIb	$100 \leqslant \text{CTI} < 175$

The CTI values mentioned above refer to values obtained on samples specifically made for the purpose and tested with solution A, in accordance with IEC 112

NOTE For inorganic insulating materials, for example glass or ceramics, which do not track, creepage distances need not be greater than their associated clearances for the purpose of insulation co-ordination.

Section 2. Requirements and tests

5 Test conditions

The tests shall be carried out on new, dry and completely assembled welding power sources. The heating tests according to Clause **7.1** shall be carried out at an ambient air temperature of (20 ± 2) °C. The ventilation shall be identical with that prevailing under normal service conditions. The measuring devices used shall not interfere with the normal ventilation of the welding power source or cause transfer of heat to or from it.

The accuracy of measuring instruments shall be:

a) electric measuring instruments: Class 0.5,

b) thermometer : ± 2 K.

Unless otherwise specified, the tests required in this standard are type tests.

The sequence for some of the type tests is specified in Clause **5.1**. The routine tests are specified in Clause **5.2**.

Compliance with other standards referred to, shall be checked according to these standards.

Unless the manufacturer presents proof that separate components and accessories supplied with the welding power source comply with the relevant standards (by test certificates, conformity marks etc.), their compliance shall be checked according to the relevant standards.

5.1 Type tests

All type tests shall be carried out on the same welding power source and those given below shall be carried out in the following sequence:

a) General visual inspection (see Clause **4.7**),

b) Insulation resistance (see Clause **6.1.3**) (preliminary check),

c) Impact resistance (see Clause **11.1**),

d) Carrying means (see Clause **11.2**),

e) Drop withstand (see Clause **11.3**),

f) Thermal rating (see Clause **7**),

g) Ingress of water (see Clause **6.2**),

h) Insulation resistance (see Clause **6.1.3**),

i) Dielectric strength (see Clause **6.1.2**),

j) General visual inspection (see Clause **4.7**).

The other tests of this standard not mentioned above may be carried out in any convenient sequence.

NOTE The preliminary check on insulation resistance is recommended to determine whether the carrying out of the subsequent tests is warranted.

5.2 Routine tests

Each welding power source in the cold state at ambient air temperature shall be submitted successively to the following routine tests:

a) General visual inspection (see Clause **4.7**),

b) Protective conductor connection (see Clause **6.3.1**),

c) Rated no-load voltage (see Clause **10.1**),

d) Insulation resistance (see Clause **6.1.2**),

e) Dielectric strength (see Clause **6.1.3**),

f) Maximum and minimum welding current (see Clause **10.4**),

g) General visual inspection (see Clause **4.7**).

6 Protection against electric shock

6.1 Insulation

6.1.1 *Clearances and creepage distances*

Welding power sources for limited duty may be used in environments of pollution degree 3 but are not intended for use in pollution degree 4.

Components or sub-assemblies with clearances or creepage distances corresponding to pollution degree 2 are permitted, if they are completely enclosed, coated or encapsulated.

The following values apply for pollution degree 3:

Table I — Minimum clearances and creepage distances for basic insulation and supplementary insulation

Rated maximum voltage V r.m.s.	Clearance mm	Creepage distance mm			Clearance and creepage distance for terminals mm
		Material group			
		I	II	IIIa	
0 – 50	0.8	1.5	1.7	1.9	6
51 – 130	1.5	1.9	2.1	2.4	6
131 – 250	3	3.2	3.6	4	6
251 – 415	5.5	5.5	5.6	6.3	6

Creepage distances are given for the highest rated voltage of each line of Table I. In case of lower rated voltages interpolation is allowed.

Interpolation of clearances is not allowed.

The last column applies to all kinds of terminals when not specially protected.

Clearances and creepage distances of parts of the welding power source (e.g. electronic circuits or components) which are protected by an overvoltage limiting device (e.g. metal oxide varistor) may be rated according to the residual voltage level (special protected level, over-voltage category I, see IEC 664).

The values of Table I shall also be applicable to the welding circuit within the welding power source and to control circuits when separated from the supply circuit, e.g. by a transformer.

If the control circuit is directly connected to the supply circuit, the values for the supply voltage shall apply.

For reinforced insulation the values given in Table I shall be doubled except for terminals.

NOTE Clearances and creepage distances for rated voltages not mentioned in Table I, see IEC 664.

Compliance shall be checked by linear measurement.

6.1.2 ***Insulation resistance***

The insulation resistance shall be not less than the values given in Table II.

Compliance shall be checked by the stabilized measurement of the insulation resistance without interference suppression or protection capacitors at room temperature by application of a d.c. voltage of 500 V.

Solid state electronic components and their protective devices may be short-circuited during the measurement.

6.1.3 ***Dielectric strength***

The insulation shall withstand the test voltages of Table II without flashover or breakdown after the humidity treatment.

The a.c. test voltage shall be of an appropriate sine wave form with the peak value not exceeding 1.45 times the r.m.s. value, having a frequency of approximately 50 or 60 Hz.

NOTE Care shall be taken that the test voltage applied between input and output circuits does not overstress other insulation. If it is stated by the manufacturer that e double insulation system exists between input and output windings, such as from input winding to core and from core to output winding, each insulation shall be tested separately with a test voltage according to Table II. The same applies to double insulation between the input winding and any exposed conductive part.

For Class II welding power sources incorporating both reinforced and double insulation, care shall be taken that the voltage applied to the insulation does not overstress the basic or supplementary insulation. The same applies to double insulation if the basic and supplementary insulation cannot be tested separately.

Compliance shall be checked by the following test:

a) *Humidity treatment*

Welding power sources shall be tested with the power supply cable and the supply cable entries correctly fitted. Electrical components, covers and other parts which can be removed without the aid of a tool are removed and subjected, if necessary, to the humidity treatment with the welding power source.

The humidity treatment shall be carried out in a humidity cabinet containing air with a relative humidity maintained between 91 % and 95 %. The temperature of the air, at all places where specimens can be located, is maintained to within 1 K of any convenient value θ between 20 °C and 30 °C.

Before being placed in a humidity cabinet, the welding power source is brought to a temperature between θ and $\theta + 4$ °C.

The welding power source shall be kept in the cabinet for seven days (168 h).

NOTE In most cases, a welding power source may be brought to the specified temperature by keeping it at this temperature for at least 4 h before the humidity treatment.

b) *Dielectric strength test*

Initially not more than half the specified voltage need be applied, then it shall be raised within 10 s to the full value and maintained for 60 s. At the end of this time the voltage shall be rapidly diminished to less than half of its full value before being switched off.

The high-voltage transformer used for the test shall be capable of supplying a current of at least 200 mA when the output terminals are short-circuited. The overload releases of the circuit shall not operate for any current less than 100 mA.

As a routine test, the full value of the above given voltage shall be applied for 10 seconds between:

1) input circuit and welding circuit, connected with any exposed conductive part and

2) welding circuit and any exposed conductive part.

Welding power sources incorporating a rectifier shall be tested after assembly of the complete welding power source with the power rectifier remaining properly connected to the output circuit of the transformer. Rectifiers, their protective devices and other solid state electronic components or capacitors may be short-circuited during the test.

Table II — Dielectric test voltages and insulation resistances

	Exposed conductive part		Control circuit when separated from the input circuit		Welding circuit	
	U V r.m.s.	*R* Megohms	*U* V r.m.s.	*R* Megohms	*U* V r.m.s.	*R* Megohms
Input circuit including any circuit directly connected Protection II Class I	 4 000 2 500	 5 2.5	 4 000 2 500	 5 2.5	 4 000 4 000	 5 5
Control circuit 55 V and higher lower than 55 V	 1 500 800	 2.5 2.5	 1 500 800	 2.5 2.5	 4 000 —	 5 —
Welding circuit	1 500	2.5	1 500	2.5	—	—

Solid state electronic components, incorporated wholly within either the input circuit or the welding circuit or exposed conductive parts (e.g. case work, frame) and not connecting any two of them, may be disconnected or short-circuited during the dielectric strength test.

Interference suppression or protection capacitors between the input or welding circuit and any exposed conductive parts may be disconnected if they comply with the relevant standards.

6.2 Protection against electric shock in normal service (direct contact)

The degree of protection provided by enclosure shall be at least IP 21 in accordance with IEC 529 and shall be such that:

a) a 50 mm long test pin from all sides except the underside and

b) a 15 mm long test pin from the underside

cannot be inserted to touch live parts of the input circuit or in the case of Class II welding power sources any metal part which is separated from live parts only by basic insulation.

The welding output connections shall be in accordance with Clause **10.6**.

Welding power sources built with a degree of protection of IP 21 shall be marked that they are not suitable for use or for storage in rain.

Compliance shall be checked:

1) according to IEC 529,

2) by the test pins (see Appendix A, Figure 4 and Figure 5) applied by a force of 5 ± 1 N.

NOTE It is recommended that handles for transportation or current control of Class I welding power sources are made of or covered with insulating material.

6.2.1 ***Capacitors***

Welding power sources shall be so designed that there is no hazard of electric shock from charged capacitors.

One second after disconnection, the voltage across the capacitor(s) shall not exceed 34 V.

Capacitors having a rated capacitance not exceeding 0.1 µF are not considered to entail a risk of electric shock.

Compliance shall be checked by the following test:

The welding power source shall be operated at rated supply voltage or at the upper limit of the rated supply voltage range.

The switch, if any, is then moved to the "off" position and the welding power source is disconnected from the supply. The voltage shall be measured with an instrument which does not appreciably affect the value to be measured.

6.3 Protection against electric shock in case of a fault condition (indirect contact)

Welding power sources shall be of protection Class I or II construction according to HD 366 (IEC 536) with the exception of the welding circuit.

Compliance shall be checked by visual inspection.

6.3.1 ***Protection Class I***

The exposed conductive parts of a welding power source shall be bonded to the terminal for the external protective conductor.

The resistance between the connecting means and any exposed conductive part shall not exceed 0.1 ohm.

Compliance shall be checked by visual inspection and the following test:

To measure the resistance, a current of 25 A from an alternating current source with a no-load voltage not exceeding 12 V is caused to flow successively from the protective-conductor terminal to every exposed conductive part which may become live in the case of a fault.

The resistance is calculated from the measured voltage and the current.

6.3.2 ***Protection Class II***

Protection Class II welding power sources shall not be fitted with a terminal for an external protective conductor.

Metal housings of capacitors shall be insulated by supplementary insulation from exposed conductive parts.

Compliance shall be checked by visual inspection.

6.3.3 ***Isolation of input and welding circuit***

The welding circuit shall be electrically isolated from the input circuit (e.g. by separate windings with reinforced or double insulation).

The welding circuit shall not be connected internally to the protective conductor, the enclosure, frame or core of the welding power source.

Compliance shall be checked by visual inspection and during the tests according to Clauses **6.1.2** and **6.1.3**.

6.3.4 ***Insulation between input and welding circuit***

Windings of the input and the welding circuit shall be insulated by:

a) reinforced insulation or

b) basic insulation to a metal screen between them, which is connected to the protective conductor.

Between the windings of the input and the welding circuit there shall be insulating material having a thickness of at least:

c) 1 mm in the case of 1 single layer or

d) 0.3 mm in the case of 3 or more separate layers or there shall be

e) an air gap of 6 mm.

The windings shall be securely fixed to ensure that they cannot become loose unintentionally.

Bare conductors of the input circuit shall be separated from bare conductors of the welding circuit by not less than:

f) 25 mm of air or

g) 1 mm of solid insulation.

Compliance shall be checked by visual inspection and by linear measurement.

6.3.5 ***Placing of internal conductors***

Internal conductors and connections shall be placed and secured in such a way that breakage or loosening can cause no electrical connection between:

a) the input circuit or any other circuit and the welding circuit, such that the output voltage could become higher than the allowable no-load voltage and

b) the welding circuit and the protective conductor, enclosure, frame or core.

Where insulated conductors pass through metallic parts, they shall be provided with bushes of insulating material or the openings shall be bell-shaped with a radius of at least 1.5 mm.

Bare conductors shall be so fixed that the distance from each other and from the metal enclosure, frame or core is adequately maintained.

Compliance shall be checked by visual inspection and by measurement.

6.3.6 ***Movable coils and cores***

If movable coils or cores are used to adjust the welding current, the construction shall be such that the prescribed clearances and creepage distances are maintained, taking into account the electrical and mechanical stresses.

Compliance shall be checked by operating the mechanism 500 times over its complete movement from minimum to maximum or vice versa at a rate as specified by the manufacturer and by visual inspection.

7 Thermal rating

The thermal rating of a welding power source shall be:

a) for windings, according to Clause **7.3.1**,

b) for external surfaces, according to Clause **7.3.2**,

c) for the materials of other parts, according to the temperatures which occur in the welding power source as determined during the heating test.

The manufacturer shall make available to any test house the specification of the materials used in the welding power source.

7.1 Heating test

For each rated welding current according to Table III, given on the rating plate, the welding power source shall be operated at conventional welding conditions from the cold state (20 ± 2) °C and with a duty cycle (duty factor) taking into account:

— the melting time t_f of the electrode corresponding to the rated welding current I_2 and

— a no-load time of 20 s corresponding to the time necessary to place a new electrode, to chip the slag and to brush the weld. The no-load shall be obtained by breaking the output circuit.

Table III — Conventional values based on the reference electrode

Diameter	ϕ	mm	1.6	2.0	2.5	3.2	4.0
Usable length		mm	200	250	300	300	300
Welding current	I_2	A	40	55	80	115	160
Melting time	t_f	S	38	52	56	60	76

This test shall be continued for one hour after the first reset of the thermal cut-out device (see Figure 1).

During the heating test the output current I_2 shall be maintained by ± 5 % by adjustment of the conventional load or the mains voltage within a ± 10 % margin.

The following measurements shall be made:

a) t_c the heating time from the cold state and

b) t_h the heating time from the hot state.

From these measurements shall be calculated:

c) n_c the number of reference electrodes, which can be melted from the cold state, by the formula:

$$n_c = \frac{t_c}{t_f + 20}$$

d) n_h the mean value of the number of reference electrodes which can be melted between resetting and operation of the thermal cut-out device, by the formula:

$$n_h = \frac{\bar{t}_h}{t_f + 20}$$

where $\bar{t}_h$ is the mean value of the values of t_h, measured during the heating test.

n_h shall be not less than 1 (see **10.3**).

e) n_{c1} the number of reference electrodes which can be melted within the first hour from the cold state, by the formula:

$$n_{c1} = \frac{t_c + \Sigma_A t_h}{t_f + 20}$$

where $\Sigma_A t_h$ is the sum of heating times during the first hour with the welding power source starting from the cold state (see Figure 1).

f) n_{h1} the number of reference electrodes which can be melted within one hour from the hot state, by the formula:

$$n_{h1} = \frac{\Sigma_B t_h}{t_f + 20}$$

where $\Sigma_B t_h$ is the sum of heating times during one hour with the welding power source at the hot state starting from resetting (see Figure 1).

If the welding power source can only be adjusted in steps, the test shall be done with the setting immediately above the rated output current I_2 for the corresponding electrode diameter.

If the thermal cut-out device does not operate, n_c and n_{c1} are equal and are calculated by:

$$n_c = n_{c1} = \frac{3600}{t_f + 20}$$

On the rating plate the number of electrodes shall be given as the nearest whole number.

7.2 Methods of temperature measurement

The temperature shall be measured as follows:

a) for windings, by means of the resistance method or by means of the thermometer method at the hottest accessible spot on the surface of the winding;

b) for other parts, by means of the thermometer method.

It is not intended that measurement by both methods shall be used; one method only shall be chosen to determine the temperature of any particular part.

NOTE In the case of windings of low resistance having switch contacts in series with them, the resistance method can give misleading results.

7.2.1 *Thermometer method*

In this method, the temperature is measured by a temperature measuring device applied to accessible surfaces of windings or other parts in accordance with the conditions stipulated below.

Temperature-measuring devices are e.g. thermocouples, resistance thermometers.

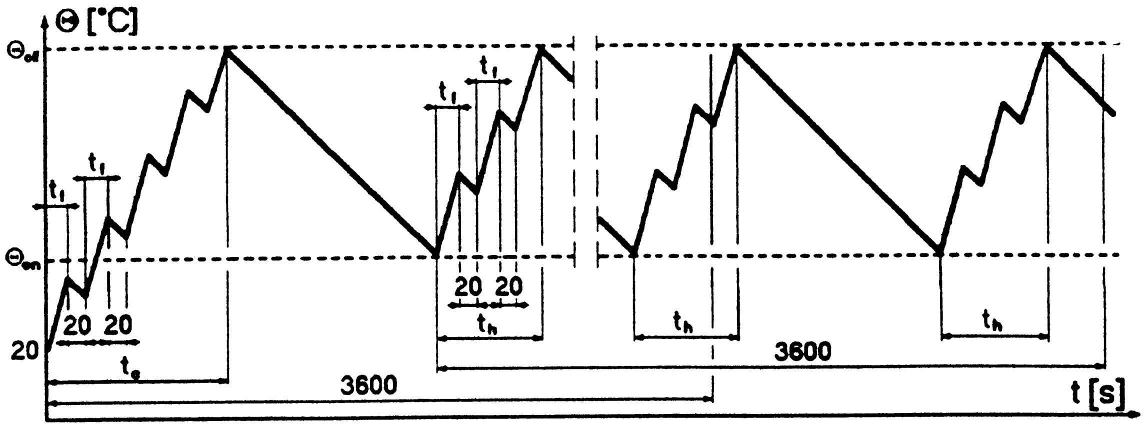


Figure 1 — Temperature curve of windings

Bulb thermometers shall not be used for measuring temperatures of windings and surfaces.

NOTE Generally, welding power sources have hot spots in their windings, the size and spread of which depend essentially on the design.

Thermometers shall be placed at accessible spots where the maximum temperature is likely to occur.

Efficient heat transmission between the point of measurement and the thermometer shall be ensured, and protection shall be provided for the thermometer against the effect of air currents and radiation.

7.2.2 ***Resistance method***

In this method, the temperature rise of windings is determined by increase of resistance and is obtained for copper by the formula:

$$\theta_2 - \theta_a = \frac{(R_2 - R_1)}{R_1}(235 + \theta_1) + (\theta_1 - \theta_a)$$

where

- θ_1 is the temperature in °C of the winding at the moment of the initial resistance measurement,
- θ_2 is the temperature in °C of the winding at the end of the test (calculated value),
- θ_a is the ambient air temperature in °C at the end of the test,
- R_1 is the initial resistance of the winding in ohms,
- R_2 is the resistance of the winding at the end of the test in ohms.

For aluminium, the number 235 in the above formula shall be replaced by the number 225.

The temperature θ_1 shall be that of the ambient air ± 3 K.

7.3 Limits of temperature

7.3.1 ***Windings***

The operating temperature (Θ_{off}) shall not exceed the values of Θ_{max} given in Table IV.

Table IV — Limits of temperature for windings (Θ_{max})

Insulation class	Θ_{max} in °C	
	determined on the surface	**determined by resistance**
A (105 °C)	114	120
E (120 °C)	132	138
B (130 °C)	138	144
F (155 °C)	162	174
H (180 °C)	190	200
200 (200 °C)	210	220
220 (220 °C)	230	240

The temperature of the surface shall be measured by using non-embedded thermometers (e.g. thermocouple, resistance thermometer) at the hottest accessible spot of the outer surface of the windings.

For certain insulation materials temperature rises higher than these given above are allowed according to IEC 85.

Compliance shall be checked by measurement during the heating test according to Clause **7.1**.

7.3.2 ***External surfaces***

The temperature rises for external surfaces in the following cases shall not exceed:

a) Metal enclosures, bare 25 K
b) Metal enclosures, painted 35 K

c) Non-metallic enclosures 45 K
d) Metal handles 10 K
e) Non-metallic handles 30 K

Compliance shall be checked by measurement during the heating test according to Clause **7.1**.

7.3.3 ***Rectifier elements***

The temperature of rectifier elements shall not exceed the limit specified by their manufacturers.

Compliance shall be checked by measurement during the heating test according to Clause **7.1**.

8 Thermal protection

Welding power sources shall be fitted with a thermal cut-out device.

Compliance shall be checked by visual inspection.

8.1 Construction of thermal cut-out device

Thermal cut-out devices shall be so constructed that it is not possible to change their temperature setting without inflicting obvious physical damage upon the device.

Compliance shall be checked by visual inspection.

8.2 Location

Thermal cut-out devices shall be permanently located within the welding power source in such a way that the heat transfer is reliable.

Compliance shall he checked by visual inspection.

8.3 Operation

The thermal cut-out device shall operate before the temperature of the welding transformer windings exceeds the temperature θ_{max} given in Table IV or before the temperature of the rectifier elements exceeds its limit.

Compliance shall be checked by measurement during the heating test according to Clause **7.1**.

8.4 Resetting

The thermal cut-out device shall be able to reset only when the temperature has dropped to a value that fulfills the requirements of Clause **10.3**.

Compliance shall be checked according to Clause **10.3**.

8.5 Operating capacity

The thermal cut-out device shall be capable of breaking either the supply current or the welding current 200 times consecutively without failure whilst the welding power source delivers the maximum rated welding current.

Resetting shall take place with the welding circuit open.

On completion the requirements of Clause **8.3** and **8.4** shall be met.

Compliance shall be checked by operation of the thermal cut-out device.

When the above endurance test has been completed, the same type of thermal cut-out device shall be fitted into the welding power source and shall be tested by 10 cycles of operation and resetting according to Clause **7.1**. This may be part of the heating test.

As a sampling test 1 in every 1 000 welding power sources of the same type shall be operated at rated supply voltage and frequency and at rated maximum welding current from the cold state (20 ± 2) °C up to the operation of the thermal cut-out device. The heating time from the cold state (t_c) shall be within ± 20 % of that determined during the type test according to Clause **7.1**.

8.6 Indication

Welding power sources shall be fitted with an indicator, preferably yellow (e.g. a yellow signal light) to show when the thermal cut-out device is operating.

NOTE An additional white indicator (e.g. white signal lamp) may show that the main supply to the welding power source is switched on.

Compliance shall be checked by visual inspection.

8.6.1 ***Filament signal lamps***

Filament signal lamps shall be so arranged that they can be removed and replaced manually.

Compliance shall be checked by lamp replacement.

9 Connection to the main supply

9.1 Supply voltage

The rated maximum supply voltage shall not exceed 415 V r.m.s. at rated frequency of 50 or 60 Hz.

Compliance shall be checked by visual inspection.

9.2 Power switch

Welding power sources shall have an easily operated all-pole power switch which is securely fixed to the casing and cannot be removed without the use of a tool.

It shall be capable

a) of carrying continuously a current equal to that of the fuse specified on the rating plate and

b) of 10 switching operations of the supply current at rated supply voltage and frequency when the welding output is short-circuited at the maximum setting of the welding current.

After this operation the power switch shall still be suitable for further use.

Compliance shall be checked by switching the welding power source on for 2 seconds and off for 8 seconds as described in b).

9.3 Supply cable

Welding power sources shall be fitted with a flexible supply cable that shall:

a) comply with Harmonized Standards,

b) have a cross-sectional area of at least 1.5 mm^2,

c) not become heated to an excessive temperature during operation.

d) have a length of at least 2 m as measured from the exit point of the enclosure.

Compliance shall be checked by visual inspection and by temperature measurement.

After the test the terminals shall not work loose.

9.3.1 *Connection of protection Class I welding power sources*

The green and yellow coloured conductor of the supply cable shall be connected to the protective-conductor terminal. The arrangement of the terminals, or the length of the conductors between the cable anchorage and the terminals, shall be such that the current carrying conductors become taut before the protective-conductor, if the cable slips out of the cable anchorage.

The supply cable

a) shall be supplied with a plug which complies with the Standards of the country where it is to be used, or

b) may be supplied without a plug, provided all necessary information for connecting a suitable plug according to a) is attached to the supply cable, and is included in the instructions for use.

Compliance shall be checked by visual inspection.

9.3.2 *Connection of protection Class II welding power sources*

Protection Class II welding power sources for supplies up to 250 V/16 A shall be supplied fitted with a supply cable without a protective conductor and with a suitable moulded-on plug[2)] before delivery to the customer.

Compliance shall be checked by visual inspection.

9.4 Input conductor terminals

Terminals shall be provided for the connection of input conductors in accordance with Appendix B.

NOTE This requirement may also be met by using terminals on a separate device such as a switch contactor etc.

Terminals shall be clearly marked in accordance with IEC 445.

Compliance shall be checked by visual inspection.

9.4.1 *Connection at the terminals*

The connection at the terminals shall be made by means of screws or other equivalent means according to Appendix B to allow replacement of the supply cable. The terminal screws shall not be used for securing other parts or connection of other conductors.

Compliance shall be checked by visual inspection and as specified in Appendix B.

9.4.2 *Construction of the terminals*

The terminals shall be so constructed that the conductors or their lugs are clamped between metallic parts and cannot escape when the clamping means are tightened.

Compliance shall be checked by visual inspection and by temporary fixing of conductors with the minimum and maximum cross-sectional area specified.

9.4.3 *Fixing of the terminals*

The terminals shall be securely fixed so that they cannot work loose when the clamping means are tightened or loosened.

Compliance shall be checked by visual inspection and by tightening and loosening ten times the clamping means holding a conductor of the maximum cross-sectional area specified.

9.4.4 *Protective-conductor terminal*

The protective-conductor terminal shall be located near the terminals provided for the supply conductors. The connecting means shall not be used for any other purpose (such as for clamping two parts of the casing together).

The terminal shall be marked with

a) the symbol 417-IEC-5019 ⏚ or

b) the letters "PE" or

c) the twin colours green and yellow.

Compliance shall be checked by visual inspection.

9.5 Cable anchorage

Welding power sources shall have cable anchorages such that the conductors are protected from both tensile and torsional stresses at the point of entry and such that the insulation of the conductor is protected against abrasion.

Cable anchorages shall be designed and located such that:

a) cable replacement can be carried out easily;

b) the means of anchoring the cable are readily recognizable;

[2)] NOTE According to national standards of the country in which the welding power source is sold.

c) they are effective for all the different types of cable likely to be connected;

d) the cable cannot come into contact with conductive clamping screws of the cable anchorage, if these screws are accessible, or in electrical contact with exposed conductive parts;

e) the cable is not retained by a metal screw which bears directly on it;

f) at least one part of the cable anchorage is securely fixed to the welding power source;

g) any screw that needs to be loosened or tightened during cable replacement does not serve to fix any other component;

h) they are made of insulating material or provided with an insulating covering, so that an insulation fault on the cable cannot cause exposed conductive parts to become live;

i) flexible cables are protected against excessive bending at the inlet opening of the welding power source, by means of a sleeve of insulating material. The sleeves shall be fixed in a reliable manner.

j) for Class II welding power sources having inlet openings in metal, the bushes are made of a material having sufficient mechanical strength to prevent the cable coming in contact.

Compliance shall be checked by visual inspection and by pulling the supply cable 50 times with a force of 100 newton. Each pull shall be steadily applied for one second. After that the cable shall be twisted for one minute with a torque given in Table V.

Table V — Torque

Nominal cross-sectional area of the conductor mm^2	**Torque** Nm
1.5	0.25
2.5	0.375
4.0	0.5

There shall be no sign of damage to the cable which shall not have moved more than 2.0 mm from its original position, measured inside the enclosure. The conductors in the terminals and the terminals themselves shall not have moved noticeably.

After the test the cable anchorage shall not be damaged.

9.6 Dual supply voltage welding power source

Dual supply voltage welding power sources when connected in accordance with the manufacturer's instructions shall be arranged so that only the correct supply voltage can be applied to the appropriate terminals, and that contacts of any plug not in use shall not be live. (Example see Appendix C). The insulation between any plug not in use and the supply voltage shall comply with the requirements for double or reinforced insulation. The relevant diagram shall be shown in the instructions for use.

Compliance shall be checked by visual inspection and measurement.

10 Output

10.1 Rated no-load voltage

The rated no-load voltage at all possible settings at each rated supply voltage shall not exceed:

a) d.c. 113 V peak,

b) a.c. 78 V peak and 55 V r.m.s.

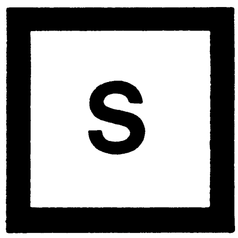
A rectifier type d.c. welding power source shall be so constructed that in case of a rectifier failure (e.g. open circuit or short-circuit or a phase failure) the allowable a.c. values cannot be exceeded.

Welding power sources are suitable for supplying power to welding operations carried out in an environment with increased hazard of electric shock if they are so constructed that the rated no-load voltages cannot exceed the following limits:

1) d.c. 113 V peak,

2) a.c. 68 V peak and 48 V r.m.s.

Such welding power sources may be marked with the symbol



The output voltage characteristic shall be sufficient at all settings for the electric arc to be struck and kept stable when using reference electrodes.

NOTE A minimum of 45 V r.m.s. fundamental sine wave is recommended.

Compliance shall be checked by measurement:

a) *R.m.s. value*

A true r.m.s. meter shall be used with a resistance of the external welding circuit of 5 kilohms ± 5 %.

b) *Peak value*

To obtain reproducible measurements of peak values, omitting impulses which are not dangerous, a circuit shall be used as shown in Figure 2.

The voltmeter shall indicate mean values. The measurement range chosen shall be as near as possible to the actual value of the no-load voltage. The voltmeter shall have an internal resistance of at least 1 megohm. The tolerance of the component values in the measurement circuit shall not exceed ± 5 %.

During the measurement the potentiometer shall be varied from 0 to 5 kilohms to obtain the highest peak value of the voltage measured with these loads of 0.2 to 5.2 kilohms. This measurement shall be repeated with the two connections to the measuring apparatus reversed.

10.2 Conventional load voltage for type tests

The welding power source shall be capable of supplying conventional welding currents at conventional load voltages throughout its range of adjustment according to the formula:

$$U_2 = 18 + 0.04I_2$$

where

U_2 is the load voltage in volt,

I_2 is the welding current in amperes.

Compliance shall be checked by sufficient measurements.

10.3 Minimum output duty

Welding power sources in the hot state shall have a minimum duty operation such that at least one complete reference electrode can be welded without operation of any thermal cut-out device i.e. n_h shall not be less than 1.

Compliance shall be checked by calculation, according to Clause **7.1**.

10.4 Maximum and minimum welding current

During the routine test the maximum and minimum conventional welding current shall comply with their rated values within ± 10 %.

Compliance shall be checked by measurement at rated supply voltage and frequency.

10.5 Control of the welding current

The control of the welding current may be continuous or in steps. The positions on the control plate shall indicate:

a) the conventional welding current and

b) the diameter of the reference electrode that can be welded. (For example see Appendix F, Figure 10 and Figure 11.)

The control setting for each electrode size shall include the value I_2 given in Table III.

Compliance shall be checked by visual inspection and electrical measurement.

10.6 Welding output connections

Coupling devices shall comply with HD 433.

Other welding output connections, with or without welding cables connected, shall be protected against unintentional contact by persons or by metal objects.

Such protection will be afforded if, for example:

a) any live part of a socket-outlet is recessed behind the plane of the access opening, or

b) a hinged cover or a protective guard is provided.

Compliance shall be checked by visual inspection.

10.6.1 ***Location of socket outlets***

Uncovered socket-outlets shall be located so that their openings are not tilted upwards.

Compliance shall be checked by visual inspection.

10.6.2 ***Outlet openings***

Where welding cables pass through metallic parts, the openings shall be bell-shaped with a radius of at least 1.5 mm.

Compliance shall be checked by visual inspection.

10.6.3 ***Welding cable anchorage***

Welding cables permanently connected to the welding power source shall be provided with a suitable cable anchorage as prescribed in Clause **9.5**.

Compliance shall be checked by a test according to Clause **9.5**.

10.7 Electrode holders

Electrode holders, if supplied with the welding power source, shall be in accordance with HD 362 and relevant standard(s) of the country in which they will be sold.

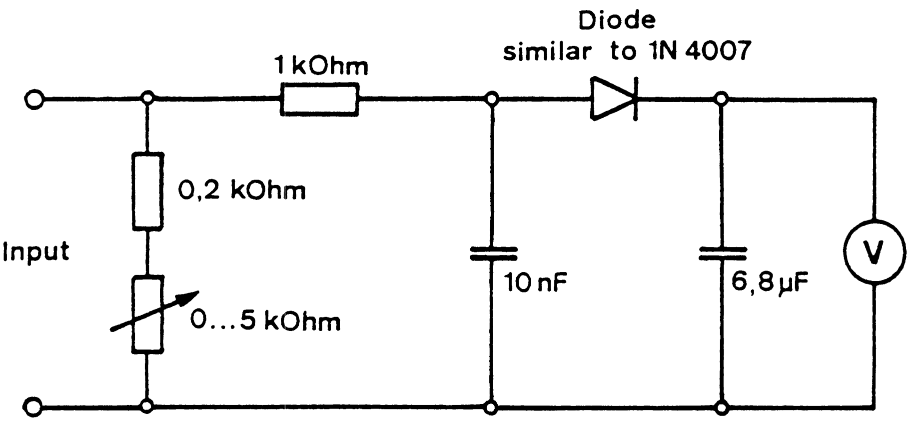


Figure 2 — Measurement of peak values

11 Mechanical requirements

A welding power source shall be so constructed that it has the strength and rigidity necessary to withstand the normal service to which it is likely to be subjected without increasing the hazard of electric shock, or other hazard and the minimum clearances required shall be maintained.

After the tests according to Clause **11.1** to **11.3** the welding power source shall comply with the provisions of this standard. Some deformation of the structural parts or enclosure is permitted provided it does not increase the hazard of electric shock.

11.1 Impact resistance

Parts of the welding power source (e.g. enclosure, handles, etc.) which may create a hazard of electric shock when damaged shall withstand the mechanical stress of the impact test without being damaged (see Clause **11**.).

Compliance shall be checked by subjecting any point that is likely to be weak to 3 blows from a spring-operated impact-hammer (see Appendix D, Figure 7) by pressing it perpendicular to the surface.

11.2 Carrying means

Welding power sources shall have one or more suitable carrying means.

NOTE Additionally wheels may also be fitted for easy transportation.

Carrying means shall be capable of withstanding the mechanical stress of the free fall jerk test without being damaged (see Clause **11**).

Compliance shall be checked by visual inspection and:

The welding power source shall be fitted with all the associated attachments that are likely to be installed. The welding power source shall then be suspended from a rigid member by a chain or cable attached to the carrying means, and it shall be positioned for a direct free fall. The chain or cable suspension assembly shall be arranged to provide for a free fall of 50 mm before the unit is caught in suspension bringing the full force of the fall to bear on the carrying means. Three falls shall be made.

11.3 Drop withstand

Welding power sources shall withstand the mechanical stress of a drop test. After the test they shall not present a risk of electric shock.

Compliance shall be checked by 3 drops onto a hard and rigid surface from a height of 250 mm. These drops shall be so arranged that each drop shall strike on a bottom edge of the welding power source different from that of any other drop.

11.4 Tilting stability

Welding power sources shall have a tilting stability up to 15° at least.

Compliance shall be checked by the following test:

The welding power source, placed for normal welding in its most unstable position, shall not topple over when placed on a plane inclined at 15° to the horizontal.

12 Rating plate

A clearly and indelibly marked rating plate shall be fixed securely to or printed on each welding power source. (Examples see Appendix E, Figure 8 and Figure 9.)

NOTE The purpose of the rating plate is to indicate to the user the electrical characteristics of the welding power source, to enable the correct selection of welding power sources to be made and to allow comparison with other welding power sources.

Compliance shall be checked by visual inspection and by rubbing the marking by hand for 15 seconds with a piece of cloth soaked with water and again for 15 seconds with a piece of cloth soaked with petroleum spirit.

After this test the marking shall be easily legible, it shall not be easy to remove the rating plate and it shall show no curling.

12.1 Description

The rating plate shall be divided into three sections:

a) The upper section contains the name of the manufacturer, distributor or importer and various information for identification of the welding power source.

b) The middle section contains all data for the welding circuit obtained from tests based on Table III.

c) The lower section contains information regarding the power supply to the welding power source.

The arrangement and sequence of the data shall comply with the principle shown in Figure 3.

The dimensions of the rating plate are not specified and may be chosen freely.

NOTE Additional information may be given on a separate plate. Other useful information, for example power factor, may be given in technical literature supplied by the manufacturer. Care should be taken to avoid misleading information which could confuse the user or purchaser e.g. short-circuit-current.

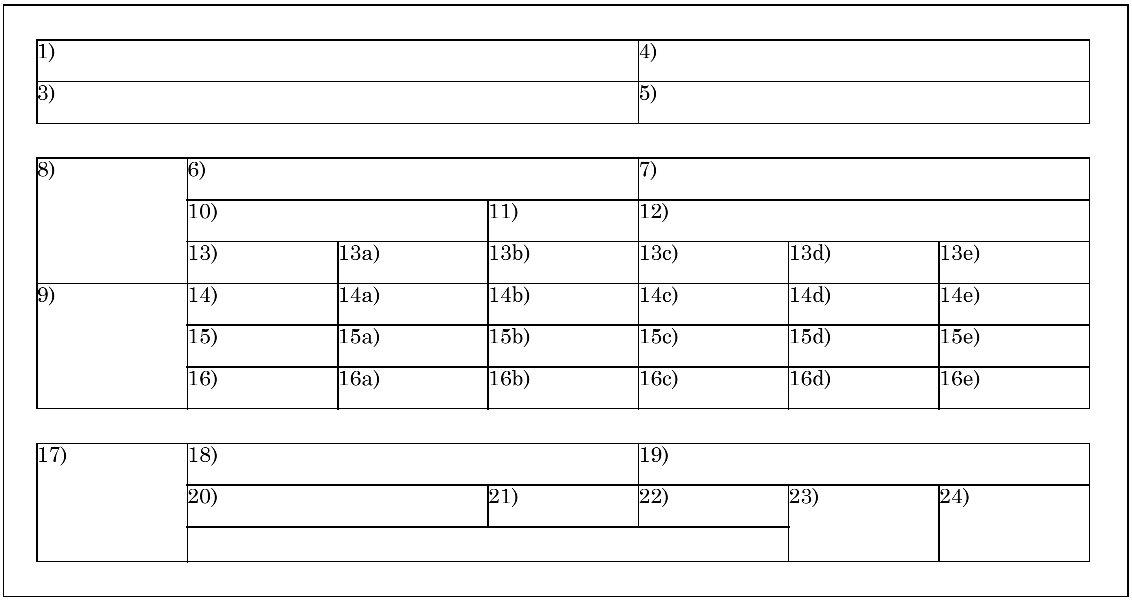


Figure 3 — Principle of the rating plate

12.2 Contents

The following explanations refer to the numbered Boxes shown in Figure 3.

Box 1 Name and address of the manufacturer, distributor or importer, if imported.

Box 2

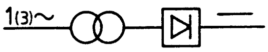
Box 3 Trademark

Box 4 Type (identification) as given by the manufacturer, distributor or importer

Box 5 Serial number

Box 6 Welding power source symbol, e.g.:

Single-phase transformer



Single (Three-) phase transformer-rectifier

Box 7 Reference to this standard and if relevant to other standards.

Box 8  Symbol for drooping characteristic

Box 9  Symbol for manual arc welding with covered electrodes

Box 10 U_o ... V — Rated no-load voltage
If several values are adjustable, the minimum and maximum rated value shall be given:
U_o ...-... V

Box 11 Welding current, e.g.:

—— Symbol for direct current

50 Hz Rated frequency for alternating current

Box 12 I_2 ...-... A — Minimum and maximum rated value of the welding current

Box 13 ϕ mm — Symbol and dimension for the diameter of reference electrodes

Box 13a to 13e — Diameter values taken from those given in Table III

Box 14 I_2 A — Symbol and dimension for the welding current

Box 14a to 14e — Values of I_2

Box 15: n_c/n_{c1} — the symbols for the number of reference electrodes capable of being melted with the welding power source

a) starting from the cold state without operation of the thermal cut-out device (n_c).
and
b) within the first hour starting from the cold state (n_{c1}).

Box 15a to 15e: n_{c1} — Values of n_c

Box 16: n_h/n_{h1} — the symbols for the number of reference electrodes capable of being melted with the welding power source

a) at the hot state without operation of the thermal cut-out device (n_h) and

b) during one hour at the hot state starting from resetting (n_{h1}).

Box 16a to 16e: n_{h1} — Values of n_h

NOTE Boxes 13a to 16e form a Table with corresponding values according to the diameter and the welding current of the reference electrode.

Box 17  Symbol for the mains supply and number of phases (e.g. 1 or 3) with the symbol for alternating current

1 ~

Box 18 U_1 ... V/50 Hz — Rated values of the supply voltage and the frequency

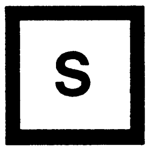
Box 19 $I_{1\ max}$ ... A_2 — Symbol, rated value and dimension of the maximum supply current

Box 20 ... A — Size of the necessary main fuse

Box 21 IP... — Degree of protection (e.g. IP 21 or IP 23)

Box 22 — Code letter for the class of insulation according to Table IV

Box 23  Symbol for Protection Class II equipment, if relevant

Box 24 

Symbol for welding power sources which are suitable for supplying power to welding operations carried out in an environment with increased hazard of electric shock

NOTE In addition it is recommended that this symbol, in a suitable size, be displayed on the front of the welding power source.

Compliance shall be checked by visual inspection and checking of complete data.

12.3 Tolerances

The data on the rating plate are derived from the results of the type tests. The individual welding power sources subsequently manufactured may have characteristics which vary from these results and therefore the following tolerances are permitted:

U_o	rated no-load voltage in V But in no case shall the values given in Clause **10.1** be exceeded.	± 5 %
I_2	rated welding current in A	± 10 %
$U_{2\ min}$	minimum conventional load voltage in V	± 5 %
$U_{2\ max}$	maximum conventional load voltage in V	± 5 %
$I_{1\ max}$	rated maximum supply current in A	± 10 %

13 Control plate

Welding power sources shall be clearly and indelibly marked with the control positions according to Clause **10.5** on a control plate (Examples see Appendix F, Figure 10 and Figure 11).

The indicated values of the welding current are at the discretion of the manufacturer and may be different from the values of Table III.

The tolerance for all indicated values of I_2 shall be according to Clause **12.3**.

Compliance shall be checked according to Clause **12**.

14 Use other than welding

If the welding power source is also designed for uses other than welding e.g. battery charging, neither use shall impose a hazard to the operator. Such a welding power source shall also comply with the standards relating to equipment for such uses.

Compliance shall be checked by additional tests according to the relevant standards.

15 Instructions for use

Each welding power source shall be delivered with an instruction sheet in the language of the country in which the welding power source is sold. This instruction sheet shall include the following information:

a) general description;

b) the meanings of marking and graphical symbols;

c) the number of reference electrodes n_c of each diameter that can be melted starting with the cold welding power source at ambient air temperature of 20 °C without operation of the thermal cut-out device;

d) the number of reference electrodes n_h of each diameter, that can be melted with the welding power source at the hot stage, starting from the resetting without operation of the thermal cut-out device;

e) welding capability, limitations of duty and explanation of thermal protection;

f) supply connections including fuse and/or circuit breaker rating;

g) the type of plug which should be used in the country where the welding power source is sold and instructions for connection;

h) type and size of welding cables to be used with the welding power source;

i) requirements for the correct connection of the welding return current cable to the workpiece;

j) correct operation of the control device and any indicators;

k) safety requirements relating to the welding power source (e.g. cooling etc.);

l) safety requirements relating to welder's clothing and accessories (insulating gloves, mask and protective eye filters, ventilation etc.);

m) isolation of electrode holders when not in use (removal of electrode);

n) a welding power source built with a degree of protection of IP 21 shall not be exposed to rain for welding or storage;

o) warning against potential hazards (e.g. electric shock, arc rays, fumes);

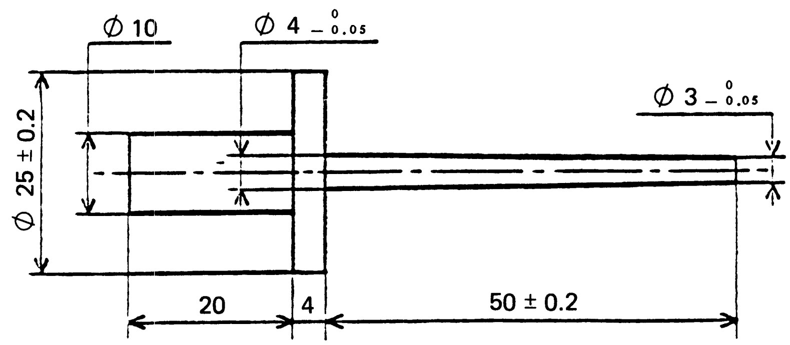
p) warning against use in certain environments (e.g. rain, damp or wet conditions, flammable surroundings, flammable products, restricted movement etc.);

q) warning that, depending on the supply mains conditions at the point of connection, the welding power source may cause interference to the supply to other electricity users. If there is any doubt about this question advice should be sought from the electricity supply authority;

r) the power factor at maximum output.

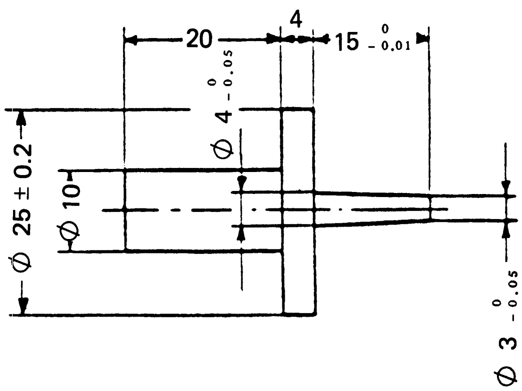
Compliance shall be checked by reading the instructions.

Appendix A Test pins



Dimensions in mm

Figure 4 — 50 mm test pin



Dimensions in mm

Figure 5 — 15 mm test pin

Appendix B Screws and connections

The following text is taken from Clause **28** HD 251 S3 (IEC 335-1).

1. Screws transmitting contact pressure shall screw into metal. Screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium. Screws of insulating material shall not be used for any electrical connection.

Compliance shall be checked by visual inspection and:

The screws or nuts are tightened and loosened 5 times.

A flexible conductor of the largest cross-sectional area as specified by the manufacturer is placed in the terminal.

The test is made by means of a suitable test screwdriver, spanner or key applying a torque as shown in the following table, the appropriate column being:

a) for metal screws without heads if the screw when tightened does not protrude from the hole: I

b) for other metal screws and for nuts: II

Nominal diameter of screw mm	Torque Nm	
	I	II
Up to and including 2.8	0.2	0.4
over 2.8 up to and including 3.0	0.25	0.5
over 3.0 up to and including 3.2	0.3	0.6
over 3.2 up to and including 3.6	0.4	0.8
over 3.6 up to and including 4.1	0.7	1.2
over 4.1 up to and including 4.7	0.8	1.8
over 4.7 up to and including 5.3	0.8	2.0
over 5.3 up to and including 6.0	—	2.5

The conductor is moved each time the screw or nut is loosened.

During the test, no damage impairing the further use of the screwed connections shall occur.

The shape of the blade of the test screwdriver must suit the head of the screw to be tested. The screws and nuts must not be tightened in jerks.

2. Electrical connections shall be so designed that contact pressure is not transmitted through insulating material which is liable to shrink or to distort, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage or distortion of the insulating material.

NOTE Ceramic material is not liable to shrink or to distort.

Compliance shall be checked by visual inspection.

3. Space-threaded (sheet metal) screws shall not be used for the connection of current-carrying parts, unless they clamp these parts directly in contact with each other and are provided with a suitable means of locking. Thread-cutting (self-tapping) screws shall not be used for the electrical connection of current-carrying parts, unless they generate a full form standard machine screw thread. Such screws shall not, however, be used if they are likely to be operated by the user or installer unless the thread is formed by a swageing action.

Thread-cutting and space-threaded screws may be used to provide earthing continuity, provided that it is not necessary to disturb the connection in normal use and that at least two screws are used for each connection.

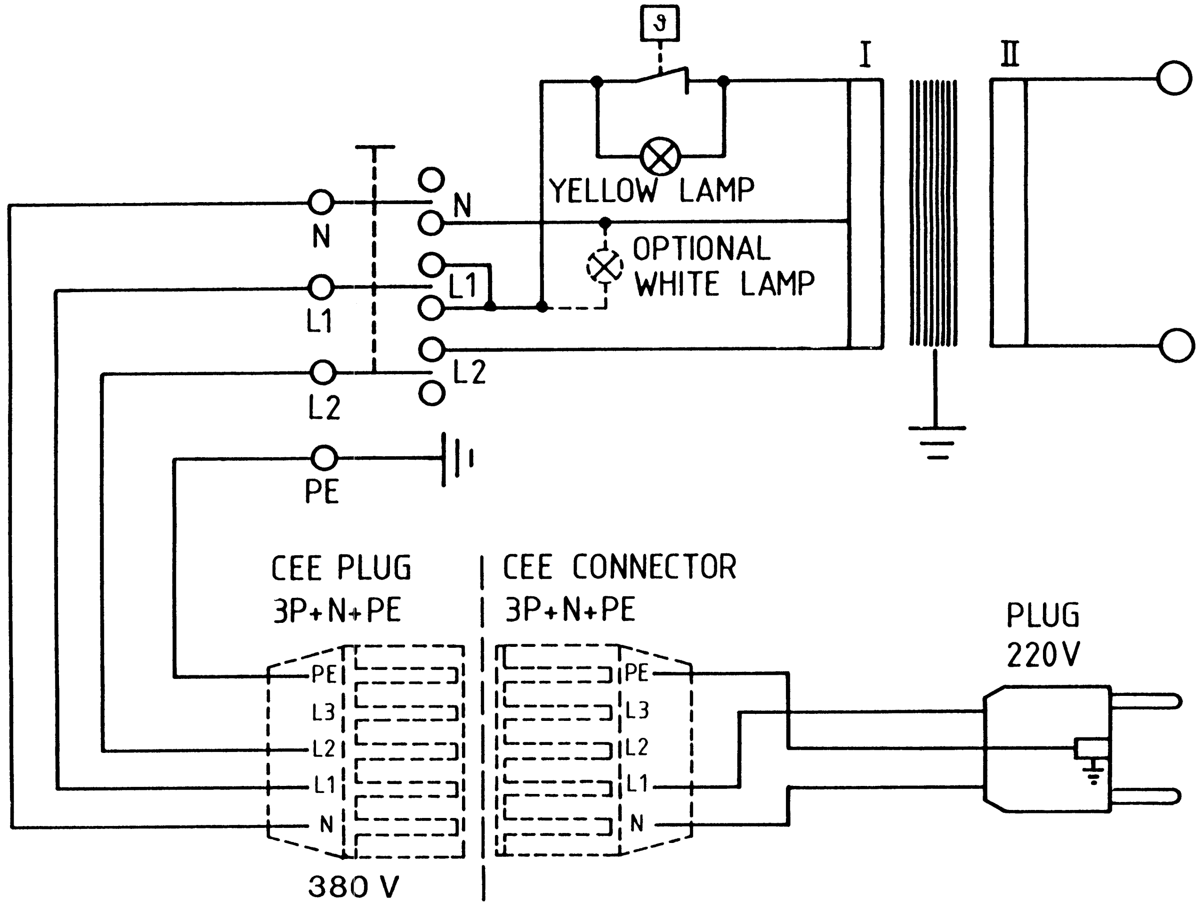
Compliance shall be checked by visual inspection.

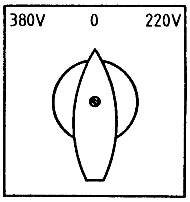
4. Screws which make a mechanical connection between different parts of the appliance, shall be secured against loosening, if the connection carries current.

Compliance shall be checked by visual inspection and by manual test.

The first requirement does not apply to screws in the earthing circuit, provided there is an alternative earthing circuit. Spring washers and the like may provide satisfactory security.

Appendix C Dual voltage welding transformer





Contacts	Switch position		
	380 V	0	220 V
N – N	open	open	closed
L1 – L1	closed	open	closed
L2 – L2	closed	open	open

Figure 6 — Example of circuit diagram of a dual voltage welding transformer and voltage change over switch

Appendix D Impact hammer

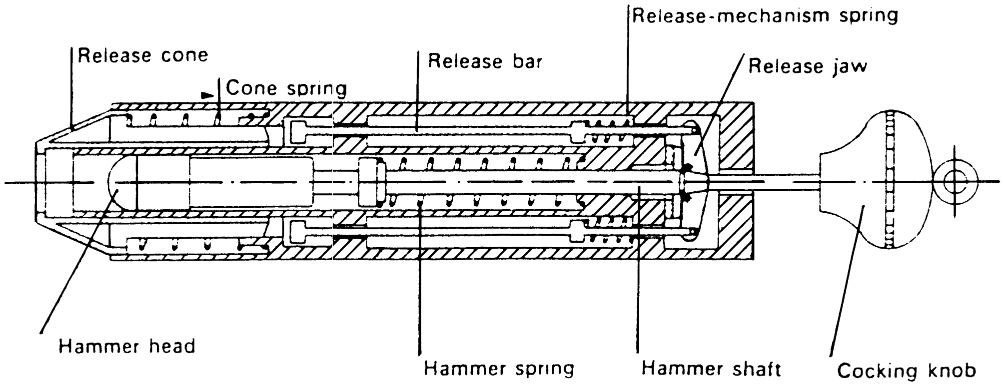


Figure 7 — Impact hammer

The impact hammer consists of three main parts: the body, the striking element and the spring-loaded release nose.

The body comprises the housing, the striking element guide, the release mechanism and all parts rigidly fixed thereto. The mass of this assembly is 1 250 g.

The striking element comprises the hammer head, the hammer shaft and the cocking knob. The mass of this assembly is 250 g.

The hammer head has a hemispherical face of radius 10 mm and is of polyamide having a Rockwell hardness of R 100: it is fixed to the hammer shaft in such a way that the distance from its tip to the plane of the front of the nose, when the striking element is on the point of release, is 28 mm.

The nose has a mass of 60 g and the nose spring is such that it exerts a maximum force of 20 N when the release jaws are on the point of releasing the striking element.

The hammer spring is adjusted so that the product of the compression in millimetres, and the force exerted, in newtons, equals 2000, the compression being approximately 28 mm. With this adjustment, the impact energy is (1 ± 0.05) Nm.

The release mechanism springs are adjusted so that they exert just sufficient pressure to keep the release jaws in the closed position.

The impact hammer is cocked by pulling the cocking knob back until the release jaws engage with the groove in the hammer shaft.

The blows are applied by pushing the release nose against the sample in a direction perpendicular to the surface at the point to be tested.

The pressure is slowly increased so that the nose moves back until it is in contact with the release bars, which then move to operate the release mechanism and allow the hammer to strike.

Appendix E Examples of rating plates

1) Manufacturer, address	4) W 120
3) Trademark	5) N^2 120.001

6)	8) 1 ~ ~		7) EN 50060			
	10) U_o 40 – 48 V		11) 50 Hz	12) I_2 35 – 120 A		
	13) ∅ mm	13a) 1,6	13b) 2,0	13c) 2,5	13d) 3,15	13e) 4,0
9)	14) I_2 A	14a) 40	14b) 55	14c) 80	14d) 115	14e) 160
	15) n_c/n_{c1}	15a) 38/54	15b) 14/24	15c) 5/13	15d) 2/6	15e) —
	16) n_h/n_{h1}	16a) 16/38	16b) 10/23	16c) 4/12	16d) 2/6	16e) —

17)	18) U_1 230 V 50 Hz		19) I_{1max} 24 A		
	20) 16 A	21) IP 23	22) H	23)	24)

Figure 8 — Example of a rating plate[a]

[a] The box numbers refer to sub-clause **12.2**

a)

1) Distributor, address	4) G 160
3) Trademark	5) N^2 160.003

b)

6)	8) 3 ~ —		7) EN 50060			
	10) U_o 40 – 48 V		11) —	12) I_2 30 – 160 A		
	13) ∅ mm	13a) 1,6	13b) 2,0	13c) 2,5	13d) 3,15	13e) 4,0
9)	14) I_2 A	14a) 40	14b) 55	14c) 80	14d) 115	14e) 160
	15) n_c/n_{c1}	15a) 51/63	15b) 19/29	15c) 7/15	15d) 3/7	15e) 1/3
	16) n_h/n_{h1}	16a) 16/32	16b) 10/23	16c) 4/12	16d) 2/6	16e) 1/3

17)	18) U_o 400 V 50 Hz		19) I_{1max} 24 A		
	20) 16 A	21) IP 23	22) H	23)	24)

Figure 9 — Example of a subdivided rating plate[a]
a) Distributor-related plate
b) Manufacturer-related plate

[a] The box numbers refer to sub-clause **12.2**

Appendix F Examples of control plates

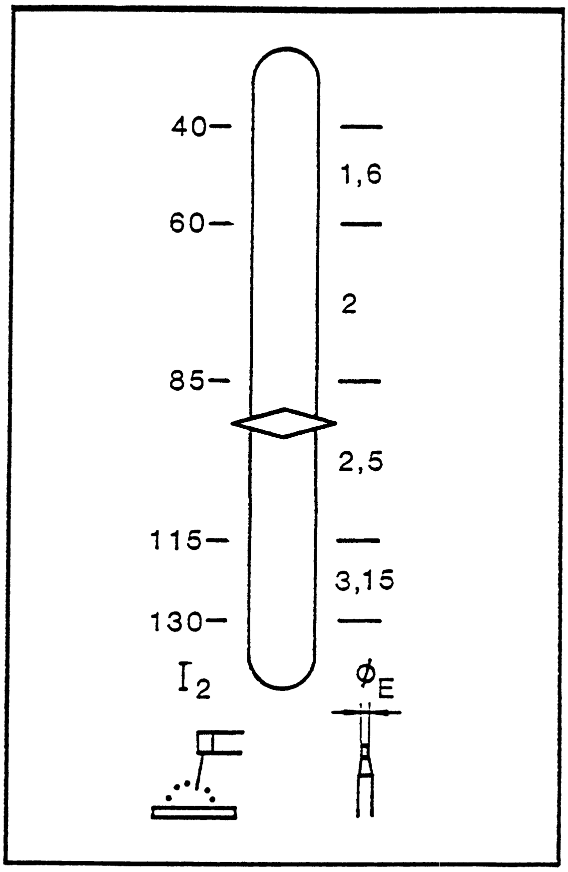


Figure 10 — Example of a control plate

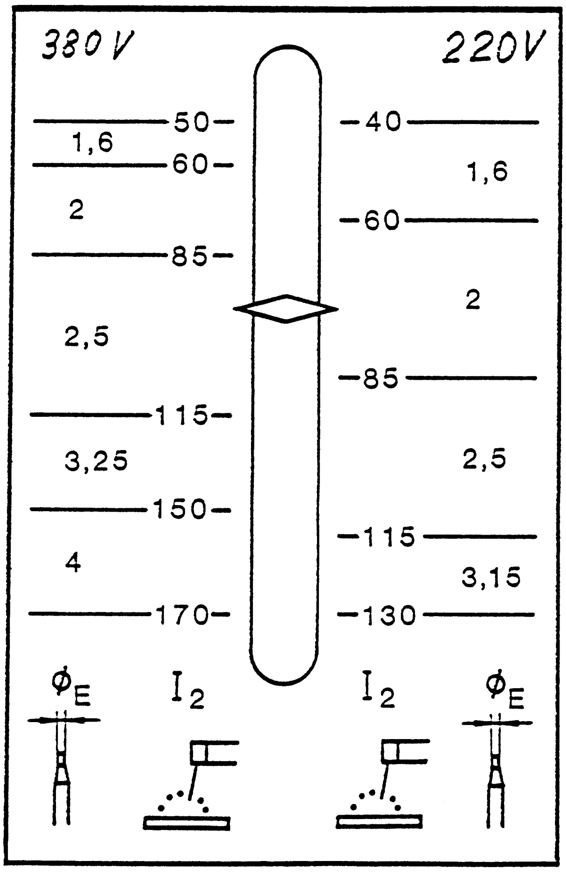


Figure 11 — Example of a control plate of a dual voltage welding power source

Appendix G Repairs of welding power sources

NOTE Experience has shown that many fatal accidents originate from poor repairs. For this reason a thorough checking of repaired welding power sources is just as important as the checking of new welding power sources.
Furthermore, producers can be protected from being held liable for defects when the blame lies elsewhere.

Repairs shall be carried out in accordance with the following requirements:

1. *Dielectric strength of rewound welding power sources*

After rewinding the dielectric strength shall withstand the test voltages given in Table II of Clause **6.1.3**.

Compliance shall be checked according to Clause **6.1.3**.

2. *Dielectric strength of non-rewound welding power sources*

If no rewinding is carried out, a welding power source, that has been cleaned and/or overhauled, shall withstand a test voltage of 50 % of the values given in Table II of Clause **6.1.3**.

NOTE The reduction of 50 % is an empirical value based on experience with insulation tests of older welding power sources.

Compliance shall be checked according to Clause **6.1.3**.

3. *No-load voltage*

After rewinding and/or replacement of parts the no-load voltage shall not exceed the values given in Clause **10.1**.

Compliance shall be checked according to Clause **10.1**.

4. *Further tests*

Further tests and operating checks shall be carried out as relevant.

5. *Marking of repaired welding power sources*

Should the repairs not be carried out by the manufacturer, repaired welding power sources, which have had components replaced or altered, shall be marked in such a way as to identify whoever carried out the repairs.

Appendix H Publications referred to

HD 251 S3, *Safety of household and similar electrical appliances* (IEC 335-1).

HD 365 S2, *Classification of degrees of protection provided by enclosures* (IEC 529).

HD 366, *Classification of electrical and electronic equipment with regard to protection against electric shock* (IEC 536).

HD 433, *Safety requirements for arc welding equipment Coupling devices for welding cables.*

IEC 85, *Thermal evaluation and classification of electrical insulation.*

IEC 112, *Method for determining the comparative and the proof tracking indices of solid insulation materials under moist conditions.*

IEC 445, *Identification of apparatus terminals and general rules for a uniform system of terminal marking using alphanumeric notation.*

IEC 664, *Insulation co-ordination within low-voltage systems including clearances and creepage distances for equipment.*

IEC 742, *Isolating transformers and safety isolating transformers — Requirements.*

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National appendix W

The United Kingdom participation in the preparation of this European Standard was entrusted by the Welding Standards Policy Committee (WEE/-) to Technical Committee WEE/6, upon which the following bodies were represented:

Association of Supervisory and Executive Engineers
British Cable Makers' Confederation
Department of Trade and Industry [Mechanical Engineering and Manufacturing Technology Division (Mmt)]
Electricity Supply Industry in England and Wales
Health and Safety Executive
National Association of Arc Welding Equipment Repairers
Power Plant Contractors' Association
Welding Institute
Welding Manufacturers' Association (BEAMA Ltd.)
Co-opted members

National appendix X

International Standard	**British Standard** (content identical)
IEC 85	BS 2757:1986 *Method for determining the thermal classification of electrical insulation*
IEC 112	BS 5901:1980 *Method of test for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*
IEC 445	BS 5559:1978 *Specification for identification of apparatus terminals and general rules for a uniform system of terminal marking, using an alphanumeric notation*
IEC 664	PD 6499:1981 *Guide to insulation co-ordination within low-voltage systems including clearances and creepage distances for equipment*

CENELEC Harmonization Document	**British Standard** (content technically equivalent)
HD 251 S3 (IEC 335-1)	BS 3456:1987 *Specification for safety of household and similar appliances* Part 101 *General requirements*
HD 365 S2 (IEC 529)	BS 5490:1985 *Specification for classification of degrees of protection provided by enclosures*
HD 366 (IEC 536)	BS 2754:1976 *Memorandum. Construction of electrical equipment for protection against electric shock*
HD 433	BS 638:1988 *Arc welding power sources, equipment and accessories* Part 5 *Specification for accessories*

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