International Standard ISO 669

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Rating of resistance welding equipment

Spécifications du matériel de soudage par résistance

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 669 was developed by Technical Committee ISO/TC 44, *Welding and allied processes*, and was circulated to the member bodies in March 1979.

It has been approved by the member bodies of the following countries :

Australia	Ireland	Poland
Brazil	Israel	Romania
Canada	Japan	Spain
Czechoslovakia	Korea, Rep. of	Sweden
Finland	Libyan Arab Jamahiriya	United Kingdom
Germany, F.R.	New Zealand	
India	Norway	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Belgium
France
Italy
South Africa, Rep. of

This International Standard cancels and replaces ISO Recommendation R 669-1968, of which it constitutes a technical revision.

Contents

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Rating of resistance welding equipment

1 Scope and field of application

This International Standard defines and specifies the characteristics of single-phase resistance welding equipment. It includes the information to appear on the equipment nameplate and specifies the test methods to be used to verify the compliance of the equipment with the requirements of this International Standard.

It is applicable to single-phase resistance welding machines, including all types of complete portable equipment[1], for use under the following conditions :

a) altitude : in the absence of any information concerning the height above sea level at which the machine is intended for use in ordinary service, the altitude shall be assumed not to exceed 1 000 m;

b) temperature of the cooling medium : in the absence of any information to the contrary, it shall be assumed that, for water-cooled machines, the temperature of the cooling water does not exceed 30 °C at the inlet of the machine and, in the case of air-cooled machines, that none of the following limits are exceeded :

1) maximum ambient air temperature 40 °C,

2) daily average ambient air temperature 30 °C,

3) yearly average ambient air temperature 20 °C;

c) pressure of cooling water : in the absence of any information to the contrary, it shall be assumed that the pressure of the cooling water is not less than that which is necessary to supply the rated quantity of cooling water (see 2.3.5).

This International Standard does not apply to multi-spot welding machines, to transformers sold separately or to capacitor discharge or rectifier machines.

2 Definitions and symbols

2.1 Electrical and thermal characteristics

For a given voltage and frequency the characteristics of the equipment are calculated, constructed and tested, as a function of the following characteristic operations :

a) intermittent operation at a duty cycle (see 2.1.5) of 50 %, the values of current and power being termed nominal and rated;

b) continuous operation, the values of current and power being termed permanent (continuous).

2.1.1 operating conditions : All quantities defining the performance of a machine.

2.1.2 rated : A qualifying term applied to a value used in the designation of resistance welding equipment.

2.1.3 duty : A schedule of the loads on an apparatus or machine, taking into account their respective duration and sequence.

2.1.4 periodic duty : A duty which is repeated periodically, the sum of one load time and no-load time being termed the weld cycle time.

NOTE — The periodic duty referred to in this International Standard comprises, for each cycle, a given working time under load, followed by a given no-load time. The load is constant, i.e. without any preheating and/or postheating period.

2.1.5 duty cycle (symbol X) : The ratio of the duration of work under load to the duration of the welding cycle time, this ratio lying between 0 and 1, and possibly expressed as a percentage.

1) A complete portable machine is one containing all elements required for operation.

2.1.6 nominal welding cycle time : A cycle having a duration of 60 s and a duty cycle of 50 %.

2.1.7 rated supply voltage (symbol U_{1n}) : The supply voltage for which the machine is constructed.

2.1.8 secondary open-circuit voltage (symbol U_{20}) : The voltage between the electrodes when the rated supply voltage is applied to the terminals of the machine at its various settings with the secondary circuit open.

2.1.9 maximum short-circuit current (primary, symbol I_{1cc} and secondary, symbol I_{2cc}) : The root mean square current at the rated supply voltage and at the highest regulator (tap) setting, the electrodes being short-circuited according to conditions laid down in the test method (see 5.2.1) and the machine being arranged so as to have successively :

a) minimum impedance (minimum throat depth and gap);

b) maximum impedance (maximum throat depth and gap).

2.1.10 maximum short-circuit power (symbol S_{cc}) : The maximum apparent power at the terminals of the machine, expressed in kilovoltamperes, measured at the highest regulator (tap) setting, the electrodes being short-circuited according to conditions laid down in the test method (see 5.2.1), and the machine being arranged in such a manner as to have the minimum secondary impedance compatible with this method of short-circuit.

$$S_{cc} = U_{1n} \times I_{1cc}$$

2.1.11 maximum welding power (symbol $S_{max.}$) : The power equal to 80 % of the maximum short-circuit power.

2.1.12 nominal power at 50 % duty cycle (symbol S_n) : The maximum electrical input (apparent power), expressed in kilovoltamperes, at the nominal welding cycle time without exceeding the specified temperature rise, when measured by the appropriate test method (see clause 5).

2.1.13 permanent (continuous) power (symbol S_p) : The power corresponding to a 100 % duty cycle, the relationship with the nominal power at 50 % duty cycle being given by the formula

$$S_p = \frac{S_n}{\sqrt{2}}$$

2.1.14 nominal current at 50 % duty cycle (symbol I_{2n}) : The highest current that can be drawn from the transformer, on all settings of the regulator, during actual or assumed operation at the nominal welding cycle, without exceeding the specified temperature rises (see clause 4).

2.1.15 permanent (continuous) current (symbol I_{2p}) : The current supplied for continuous operation, its value being given by the formula

$$I_{2p} = \frac{I_{2n}}{\sqrt{2}}$$

2.2 Geometrical characteristics (see figure 1)

2.2.1 throat gap of the machine (symbol e) (see figure 1) :

a) *for spot and seam welding machines* : the usable distance between the arms or the external current-carrying parts of the secondary, when the electrodes are in contact.

NOTE — The space requirements of the electrode-holders are not included for the purposes of this definition.

b) *for projection welding machines* : the usable distance between the platens.

c) *for butt welding machines* : the free accessible distance between both pairs of clamping jaws.

2.2.2 throat depth (symbol l) (see figure 1) :

a) *for spot, projection and seam welding machines* : the usable distance between the axis of the electrodes, the platens or the centre of the contact line of the wheels and the nearest element of the machine.

NOTE — This definition does not take into account any offset of the electrode tips.

b) *for butt welding machines* : the distance perpendicular to the direction of the upsetting force between the housing wall of the machine and the part of the clamping area located furthest from the machine.

2.2.3 stroke of the electrode (symbol c) :

a) where the electrode or the moving jaw is attached to the driving cylinder, the maximum stroke of the electrode, by convention, equals the total stroke of the driving cylinder.

b) where the moving electrode is attached to a hinged lever moved by a driving cylinder, the maximum stroke of the electrode, by convention, equals the length of the chord of the arc generated by a point on the axis of the moving electrode for a full stroke of the cylinder. This point is at the intersection of the axis of the moving electrode and the contact face for the tip of this electrode, and the electrode is arranged to give the maximum stroke.

NOTE — On certain machines, the stroke of the electrode may be composed of an "approach" with wide amplitude and without any contact, facilitating the introduction of the parts to be welded between the arms of the machine, and a "working stroke", in general, with less amplitude.

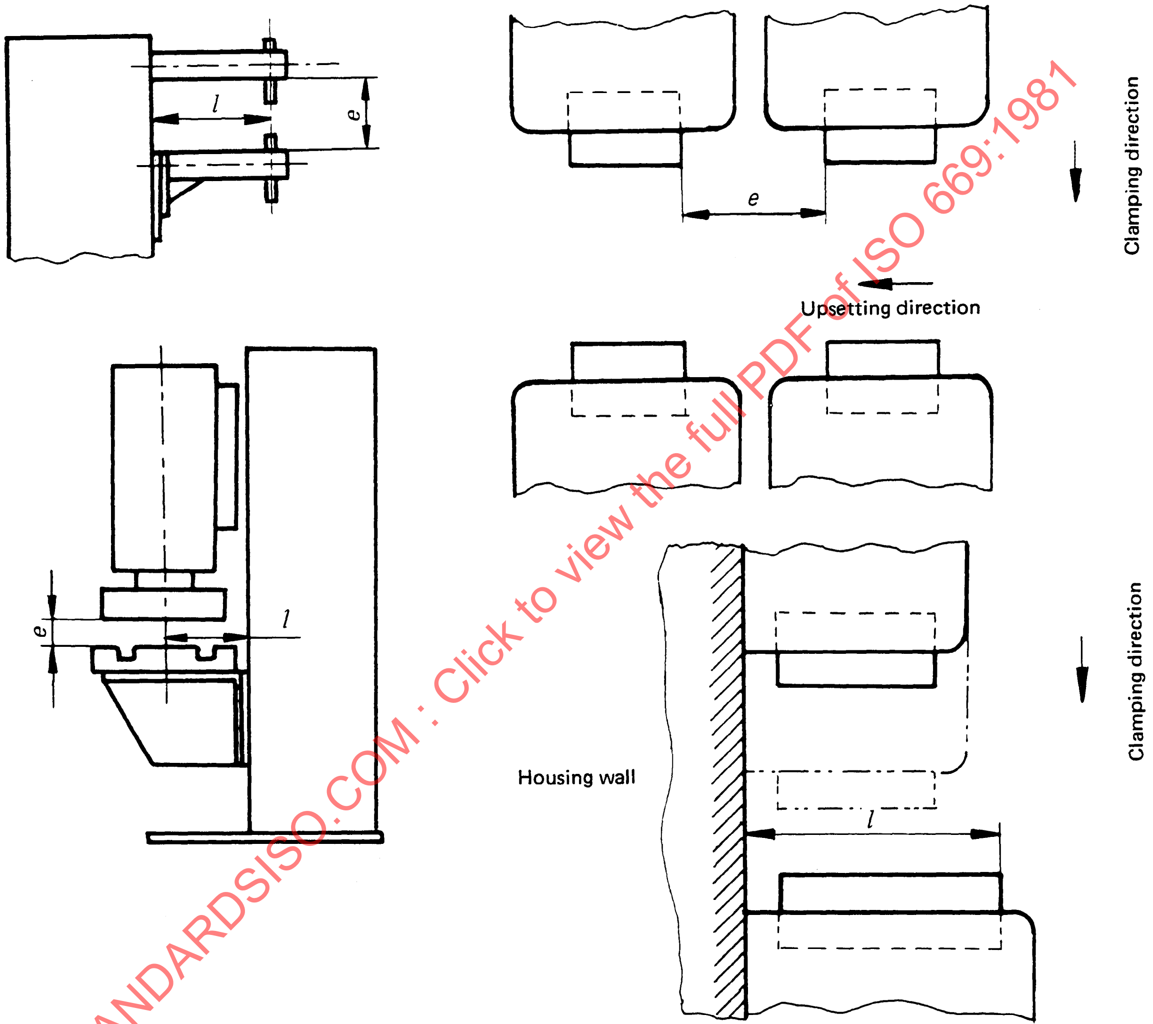

Figure 1 — Geometrical characteristics of resistance welding equipment

2.3 Mechanical characteristics

2.3.1 maximum and minimum electrode force (symbol F, for spot, projection and seam welding machines)

2.3.1.1 maximum electrode force (symbol $F_{max.}$) : The maximum force, applied to the parts to be assembled during welding, which can be withstood by the welding equipment without deleterious deformations of its mechanical parts.

2.3.1.2 minimum electrode force (symbol $F_{min.}$) : The minimum force which can be used for proper functioning of the machine.

2.3.2 maximum and minimum upsetting and maximum clamping force of butt welding machines

2.3.2.1 maximum upsetting force (symbol $F_{1\ max.}$) : The maximum compressive force, which can be used for proper functioning of the machine, applied to the parts to be assembled during welding, which can be withstood by the welding equipment without deleterious deformations of its mechanical parts.

2.3.2.2 minimum upsetting force (symbol $F_{1\ min.}$) : The minimum force which can be used for proper functioning of the machine.

2.3.2.3 maximum clamping force (symbol $F_{2\ max.}$) : The maximum force, acting through the jaws on each part to be assembled, to prevent any sliding and to maintain good electrical contact with the electrodes when the maximum upsetting force is applied.

2.3.3 supply pressure of the energizing medium (symbol p_a) : The required supply pressure of the energizing medium taken at the supply to the machine.

2.3.4 pressure of the energizing medium (symbol p) : The pressure of the medium in the driving cylinder or cylinders, at established conditions, required to obtain the maximum forces.

2.3.5 required total rate of flow of cooling agent (symbol Q) : The total quantity of circulating cooling agent, in cubic decimetres (litres) per minute, which has to be present in the cooling circuit in order to ensure that the permitted maximum temperature rise (see clause 4) is not exceeded when the equipment is operated at nominal power, S_n.

NOTE — The quantity of the cooling agent required for each circuit may also be indicated on the equipment nameplate.

2.3.6 contact fault between the working electrodes faces :

a) *for spot and seam welding machines* (see figure 2) : for any load, the misalignment between the centres of the working faces of the electrodes, expressed in millimetres.

NOTE — This definition may be expressed by indication of the angle α, in radians.

Figure 2 illustrates the definition and corresponds either to two aspects of the figure or to two successive loads as represented by the formulae

1) $\alpha = \alpha_2 - \alpha_1$

2) $g = b - a$

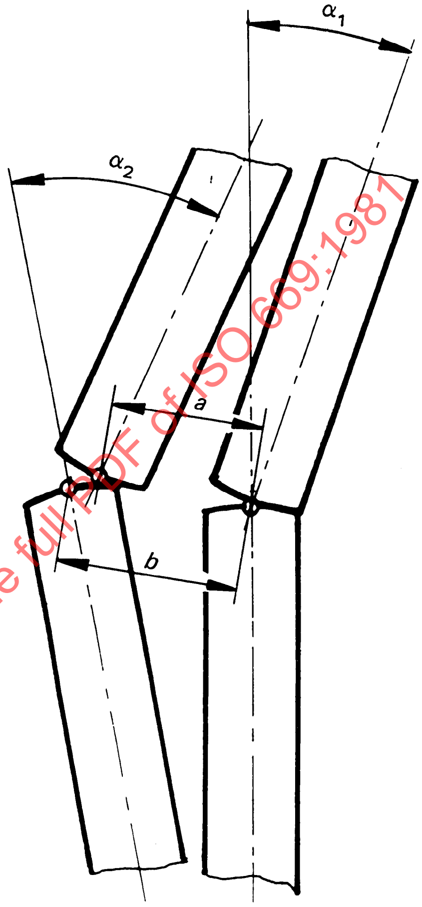

Figure 2 — Contact fault in spot or seam welding as a result of deformation of machine

b) *for projection welding machines* (see figure 3) : for any electrode force, the difference, h, between the clamping plates obtained by application of the nominal electrode force in relation to the unloaded state, and the eccentricity g, h being given by the formula

$h = b_1 - b_2$

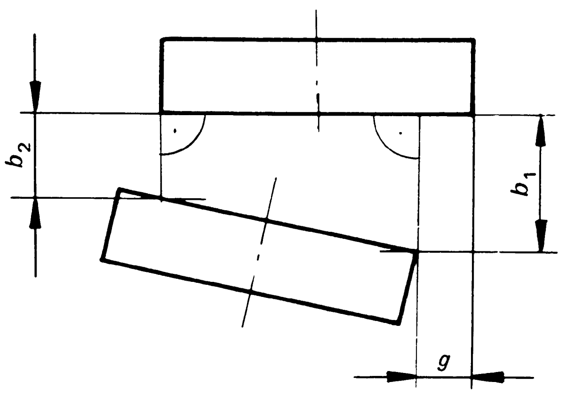

Figure 3 — Contact fault in projection welding as a result of deformation of machine

c) *for butt welding machines* (see figure 4) : the displacement, *b*, at a perpendicular to the upsetting direction, expressed in millimetres, or, alternatively, in milliradians.

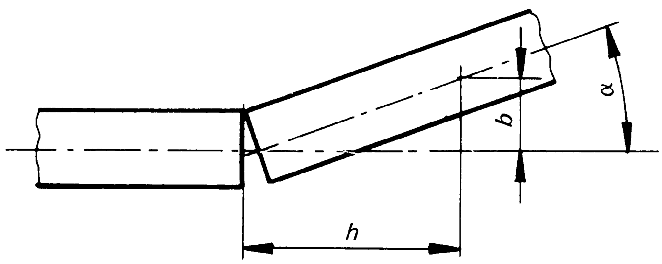

Figure 4 — Contact fault in butt welding as a result of deformation of machine

3 Conditions for temperature measurement

3.1 Air-cooled transformers

The test shall be performed at an ambient temperature of at least 10 °C. It is assumed that the rise in temperature is the same for ambient temperatures between 10 and 40 °C. The ambient temperature shall be taken as the average recorded during the last quarter of the test.

The rise in temperature shall be measured by either the resistance or thermocouple method in the case of primary windings, provided that, when using the thermocouple method, the measurement is taken at the hottest accessible point.

3.2 Water-cooled transformers

In determining the temperature rise, the actual water inlet temperature at the time of the test shall be taken into account.

The water inlet temperature shall be taken as the average recorded during the last quarter of the test. The maximum water inlet temperature shall not be higher than 30 °C.

The temperature rise shall be measured by either the resistance or thermocouple method in the case of primary windings, and by the thermocouple method or by a probe thermometer in the case of secondary windings.

When using the resistance method, the temperature shall be measured with the cooling water shut off and the load removed. The readings shall be taken as soon as possible after the measuring current has stabilized.

When using the thermocouple or thermometer method, the temperature shall be measured with the cooling water flowing and the load applied.

3.3 End of the test

The end of the test shall be the instant at which the last period under load comes to an end. The measuring methods described in 3.1 and 3.2 shall be applied as soon as possible after this instant to ensure that the temperatures of the windings are measured at their highest values.

4 Limits of temperature rise

4.1 Transformer windings

The limits of temperature rise for air-cooled and water-cooled transformers shall be in accordance with table 1.

Table 1 — Limits of temperature rise[1) 2)]

Transformer cooling medium	Method of determination	Limits of temperature rise °C for classes of insulation				
		A	E	B	F	H
Air	Resistance	60	75	85	105	130
	Thermocouple	60	75	85	110	135
	Thermometer	55	70	80	100	120
Water	Resistance	70	85	95	115	140
	Thermocouple	70	85	95	120	145
	Thermometer	65	80	90	110	130

1) The values given in this table take into account IEC Publication 85* (but are adjusted to suit resistance welding transformers).

2) For the probe thermometer and thermocouple methods, the temperature shall be measured at the hottest point of the winding.

4.2 Temperature rise in core and other parts

The temperature rises shall not exceed the limits specified in table 1 in any of the components of the transformer, whether it is air-cooled or water-cooled.

The temperature rises of the core, and other parts of the transformer in contact with the windings, shall not exceed those laid down for these windings when the tests are carried out by means of a thermometer or detachable thermocouple applied to the core.

4.3 Secondary circuit

For parts of the circuit outside the transformer, excluding the electrodes, the temperature rise shall not be greater than 60 °C.

* IEC Publication 85, *Recommendations for the classification of materials for the insulation of electrical machinery and apparatus in relation to their thermal stability in service.*

5 Test methods and requirements

5.1 General

The machine shall be new.

In determining the maximum short-circuit power, the rated primary voltage of the machine shall be used. The supply voltage under load, measured at the terminals of the machine, shall not differ by more than + 5 % or − 10 % from the rated supply voltage. Corrections may be made by taking the current as being proportional to the voltage.

Where the mains conditions make such a measurement impossible, a reduced primary voltage may be used.

If the measured short-circuit current I'_{cc} is determined at a voltage U'_1, the true value of I_{cc}, valid for the rated supply voltage U_{1n}, is given by the formula

$$I_{cc} = I'_{cc} \frac{U_{1n}}{U'_1}$$

If the equipment is fitted with an ignitron contactor control, the corresponding voltage, u, shall be subtracted from the voltage U_{1n} and U'_1 as follows.

$$I_{cc} = I'_{cc} \frac{U_{1n} - u}{U'_1 - u}$$

5.2 Determination of short-circuit secondary currents

5.2.1 Conditions of short-circuit

5.2.1.1 Spot welding and seam welding equipment

With the throat gap and the throat depth adjusted to obtain the maximum and the minimum values of impedance successively, the short-circuit shall be effected by bringing together the electrodes, having regard to the conditions given in the formula

$$d = \left(0,5 \pm 0,05\right) \sqrt{0,1\,F_{max.}} > 2,5$$

where

d is the diameter of the tip of the electrode, or the width of the thread of the wheel, in millimetres;

$F_{max.}$ is the maximum electrode force, in newtons, developed by the machine.

The spot welding electrode tips shall be flat. The wheels of the seam welding machine shall be rotating.

The electrodes and wheels shall be made from an alloy having a conductivity of not less than 80 % of that of standard annealed copper.[1)]

5.2.1.2 Projection welding machines

The short-circuit shall be effected by inserting a bar of copper between, and directly under, the centre of the platens of the machine, the cross-sectional area of the bar being sufficient to prevent it overheating. The maximum electrode force shall be applied to the machine.

The length l, in millimetres, of the copper bar placed between the platens shall be as given by the formula

$$l = 122\,F_{max.} \times 10^{-5} + 75$$

where $F_{max.}$ is the maximum electrode force, in newtons, developed by the machine.

If the minimum distance attainable between the platens is greater than the calculated length, the length shall be equal to the minimum distance + 5 mm.

A further test shall be made by inserting a bar of copper between the platens, the length of the bar being $l + e'$, where e' is the vertical distance between the lowest and highest position of the lower platen.

5.2.1.3 Flash and resistance butt welding machines (see figure 5)

The short-circuit shall be effected by inserting a bar of copper between the jaws of the machine, the cross-sectional area of the bar being sufficient to prevent it overheating and the contact surfaces being as large as is practicable. The maximum clamping force shall be applied to the machine.

1) The following resistivity laid down in IEC Publication 28, *International Standard of resistance for copper*, is taken as the normal value for standard annealed copper :

At a temperature of 20 °C the volume resistivity of standard annealed copper is 1/58 = 0,017 242 $\Omega \cdot mm^2 \cdot m^{-1}$ (ohm square millimetre per metre).

The length of the copper bar shall be determined by the distance L, in millimetres, (see figure 5) separating the opposed faces of the jaws, as given by the formula

$$L = 1{,}5 \frac{F}{W} + 2$$

where

$F = F_{1\ max.}/30$, in newtons, for machines which operate with preheating;

$F = F_{1\ max.}/150$, in newtons, for machines which operate without preheating;

W is the maximum width of the jaws, in millimetres, measured perpendicular to the direction of movement, whether the jaws are mounted horizontally or vertically on the machines.

If the length L so determined is not adjustable, it shall equal the minimum distance (throat gap e) + 5 mm.

For machines which operate with or without preheating the lowest figure shall be the basic one.

5.3 Measurement of the maximum short-circuit secondary current

This current shall be expressed as the root mean square value of the current in amperes.

5.3.1 Indirect measurement

A tolerance of − 10 % is given for the maximum secondary short-circuit current. The primary current shall be measured as shown above.

NOTE — The product of turn ratio (the ratio of the number of primary turns to the number of secondary turns) and primary current tends to give too high a value for the maximum short-circuit secondary current, if the maximum induction is close to the saturation point of the magnetizing curve. In this case, any small increase of the voltage may produce an important increase of the magnetizing current.

5.3.2 Direct measurement

A tolerance of ± 5 % is permitted for the maximum short-circuit current.

The current shall be measured as described in 5.2.1.

5.4 No-load measurement

Until the publication of an International Standard relating to separately supplied transformers for use with resistance welding machines, the following arrangements shall be applicable to transformers fitted to machines.

5.4.1 Definitions

5.4.1.1 no-load apparent power S_0 (in voltamperes) : The power absorbed when the rated voltage U_{1T} at the rated frequency of the transformer is applied to the terminals of the primary winding corresponding to the highest secondary voltage, the secondary winding(s) being open-circuited.

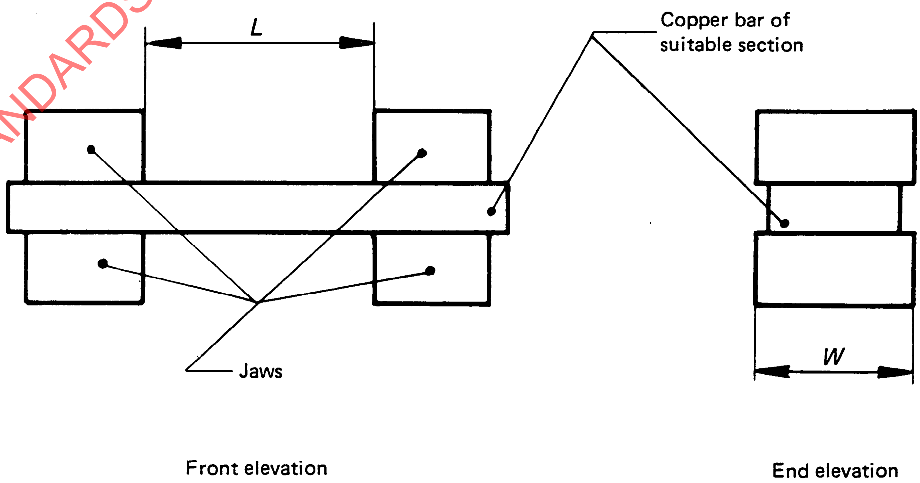

Figure 5 — Short-circuiting bar for butt welding machines

5.4.1.2 no-load current (I_{10}) : The current flowing through a line terminal of the primary winding when the rated voltage U_{1T} is applied at the rated frequency, the secondary winding(s) being open-circuited.

$$I_{10} = \frac{S_0}{U_{1T}}$$

5.4.2 Specification

When tested by the method given in 5.4.3, the no-load power shall not exceed the values given in table 2, relative to the nominal power at 50 % duty cycle. The no-load current relative to the nominal primary voltage is given for information only in table 2.

Table 2 — Maximum values for no-load power (S_0) and no-load current (I_{10})

Nominal power of transformer	S_0	I_{10} A					
		Nominal primary voltages					
kVA	VA	220 V	380 V	415 V	500 V	550 V	660 V
5	1 000	4,5	2,6	2,4	2,0	1,8	1,5
10	1 800	8,2	4,7	4,3	3,6	3,3	2,7
16	2 600	11,6	6,7	6,2	5,1	4,7	3,9
25	3 750	17,0	9,9	9,0	7,5	6,8	5,7
40	5 600	25,5	14,7	13,5	11,2	10,2	8,5
63	8 200	37,2	21,6	19,7	16,4	14,9	12,4
80	8 800	40,0	23,2	21,2	17,6	16,0	13,3
100	10 000	45,5	26,3	24,1	20,0	18,2	15,2
125	11 250	51,1	29,6	27,1	22,5	20,5	17,0
160	12 800	58,2	33,7	30,8	25,6	23,3	19,4
200	14 000	63,6	36,8	33,7	28,0	25,5	21,2
250	15 000	68,2	39,5	36,1	30,0	27,3	22,7
315	15 750	71,6	41,4	38,0	31,5	28,6	23,9
400	20 000	90,9	52,6	48,2	40,0	36,4	30,3

5.4.3 Tests

No-load power may be measured with the transformer outside or inside the machine. In the latter case it is necessary to short-circuit the ionic contactor which is in the primary circuit.

The no-load power and no-load current shall be measured by the application, to the terminals of the primary winding, of a voltage equal to the rated voltage of the transformer which appears on the nameplate of the transformer.

When measuring the no-load current, it should be noted that the current is non-sinusoidal, therefore an ammeter should be used which gives r.m.s. values.

For welding guns having in-built transformers which form an integral part of the structure of the machine, the values given in table 2 may be multiplied by the factor of 2,5. The values shall be mandatory and restricted to nominal powers up to 160 kVA.

5.5 Nominal power at 50 % duty cycle S_n

5.5.1 General test method

With the machine setting and the supply voltage set as described in 5.1, measure the short-circuit power, S_{cc}, as indicated in 5.2 and calculate the corresponding duty factor from the formula

$$S_n = S_{cc}\sqrt{\frac{X}{50}}$$

For this duty factor and a cycle of duration equal to 60 s, the limits of temperature rise specified in clause 4 shall not be exceeded.

5.5.2 Alternative methods

If the available power is not sufficient for testing the machine by the method described above, one of the following methods may be used by agreement between the manufacturer and the user. Annex A gives some technical information which may be useful for inclusion in this agreement.

5.5.2.1 Short-circuit the machine as described in 5.2 with minimum impedance. Measure with reduced primary voltage at a duty cycle of 100 %.

The primary current shall be as given by the formula

$$I_1 = \frac{S_p}{U_1}$$

5.5.2.2 Apply the rated supply voltage to the machine which shall be set to the highest secondary voltage setting, and adjust the secondary current by means of an impedance in the secondary circuit. Apply the load at some duty cycle. After having determined the corresponding power S', calculate the duty factor from the formula

$$S_n = S'\sqrt{\frac{X'}{50}}$$

where X' is the duty cycle used.

For this duty factor and a cycle of duration equal to 60 s, the limits of temperature rise specified in clause 4 shall not be exceeded.

5.6 Measurement of temperature

5.6.1 Resistance method

In this method, the temperature rise of windings is determined by the increase in resistance. For copper windings, the temperature rise is calculated from the formula

$$\frac{\theta_2 + 235}{\theta_1 + 235} = \frac{R_2}{R_1}$$

For practical purposes, the following alternative formula may be found convenient.

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

where

θ_2 is the temperature, in degrees Celsius, of the windings at the end of the test;

θ_1 is the temperature, in degrees Celsius, of the windings when cold or at the moment of initial resistance measurement;

θ_a is the temperature, in degrees Celsius, of the ambient air or of the cooling medium during the last quarter of the test;

R_1 is the initial resistance of the windings (cold);

R_2 is the resistance of the windings at the end of the test.

5.6.2 Ambient temperature

5.6.2.1 Air-cooled equipment

Thermometers shall be placed around the equipment at a distance of about 1 m, and at a height of about a half of that of the equipment. They shall be protected from all heat radiation and draughts; the bulbs may be placed in small cups of oil to even out temperature variations.

5.6.2.2 Water-cooled equipment

The thermometers shall be placed in the water supply at the inlet to the equipment.

5.6.3 Duration of heating tests

The tests shall proceed until the rate of increase of temperature does not exceed 2 °C/h.

5.7 Measurement of contact faults

The following test methods are recommended, but are not mandatory. If the methods described are not applicable to some types of machines, other suitable methods may be used as agreed between the manufacturer and the customer.

5.7.1 General conditions of test

5.7.1.1 Adjustment of the machine

The tests are carried out on a machine adjusted in such a way that maximum stroke of the electrode (2.2.3), maximum throat depth (2.2.2) and maximum throat gap (2.2.1) are obtained.

5.7.1.2 Forces

The tests are carried out with :

a) 10 % of the maximum electrode forces (2.3.1.1) or upsetting forces (2.3.2);

b) 50 % of the maximum electrode forces or upsetting forces;

c) 100 % of the maximum electrode forces or upsetting forces.

5.7.1.3 Expression of results

The results obtained are expressed in millimetres, radians, or per cent, as specified for each particular case. They are given for each value of the force. If it appears that the direction of the deflection is reversed when the force is increased, this change of direction shall be indicated with plus or minus signs as appropriate. If not, the result shall be given as an absolute value.

5.7.2 Spot and projection welding machines

5.7.2.1 Measuring accessories

Two plugs, together with a disc (see figures 6 and 7) are placed on the machine in place of the welding electrodes or at the centre of the platens in such a way that the opposite faces are parallel and the eccentricity does not exceed 0,05 mm. The disc of the plug is machined with a tolerance h6.

A ball is placed between the surfaces of the discs and centred with an appropriate flexible device.

The diameter of the ball, and the material used for the disc of the plug, are chosen so that no impression appears on the contact faces at maximum force. The contact faces, in particular, should be of hardened steel.

Dimensions in millimetres

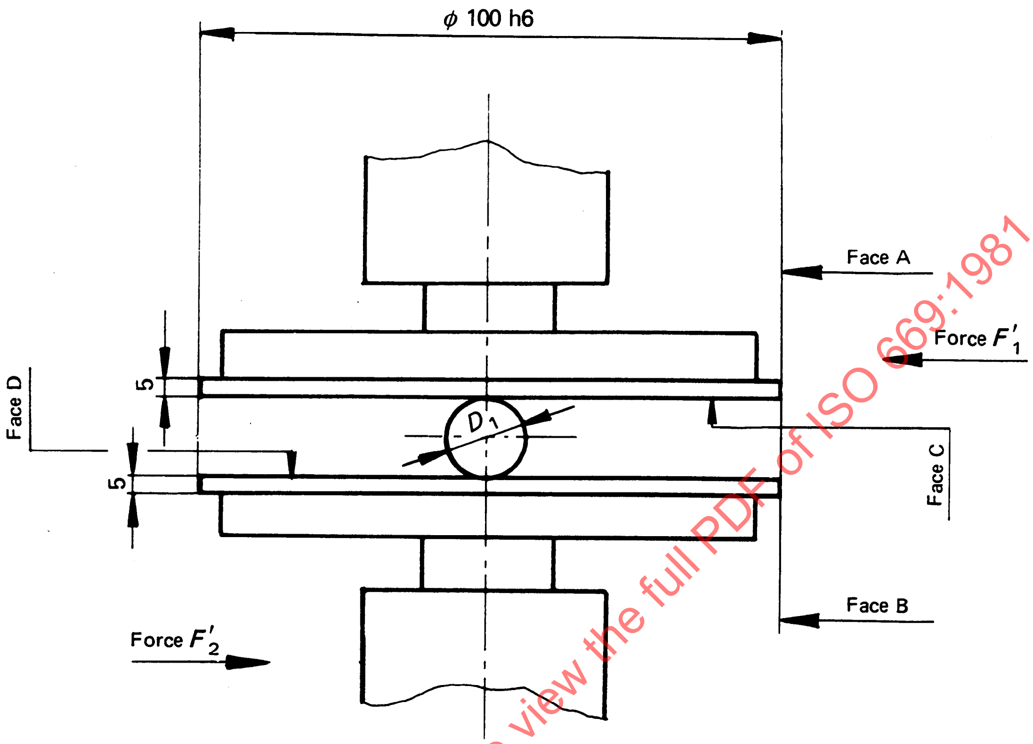

Figure 6 — Spot welding machine

Dimensions in millimetres

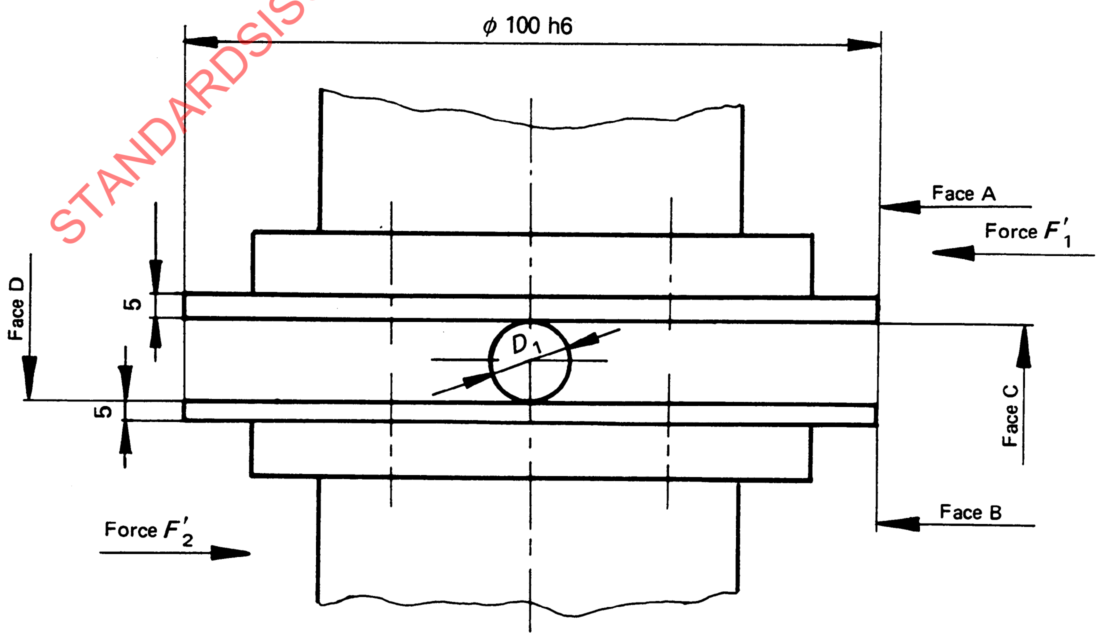

Figure 7 — Projection welding machine

5.7.2.2 Measurements (see figure 8)

The eccentricity is directly obtained by measurement of the eccentricity g with a gauge calibrated to 0,01 mm.

In order to establish the angle α or the parallel error, the distance b between the platens is measured with thickness gauges and the maximum and minimum values b_1 and b_2 are noted.

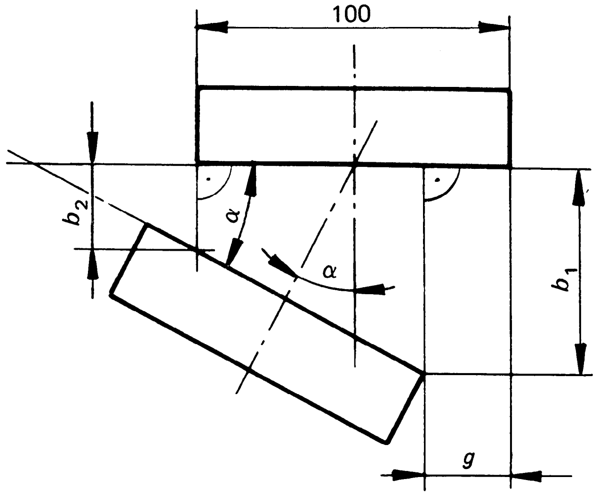

Figure 8 — Measurement of eccentricity

5.7.2.3 Expression of results

Eccentricity g is expressed in millimetres.

Calculate the angle α from the formula

$$\alpha = \frac{b_1 - b_2}{100}$$

and express its value in radians.

The parallel error is expressed by indicating the difference $b_1 - b_2$, in millimetres, or the angle, α, in radians.

NOTES

1 For rocker arm machines, the electrodes should be parallel at the beginning of the test.

2 The methods of fixing shown in figures 6 and 7 are for information only. Plugs may be fitted with adaptors to suit the machine.

3 If it is not possible to use plugs with a diameter d_1 equal to 100 mm because of the dimensions of the machine, a smaller diameter d_1, may be used, by agreement with the user. In this case, the angle α is given by the formula

$$\alpha = \frac{b_1 - b_2}{d_1}$$

4 In order to estimate the behaviour of the machine when using offset electrodes, the plugs may be subjected to the simultaneous application of :

a) the maximum electrode force;

b) two opposite forces F_1 and F_2 equal to 10 % of the appropriate electrode upsetting force, in a plane parallel to the faces C and D and in whichever direction is the less favourable for the machine (figures 6 and 7).

The eccentricity g_1 is then measured directly, in millimetres.

Similar measurements are made after the reversal of F_1 and F_2.

5.7.3 Seam welding machines

5.7.3.1 Measuring accessories

The machine is fitted with wheels which are normally delivered with it. Tooling consists of a holder with two knife edges which are applied to the lower wheels (see figure 9).

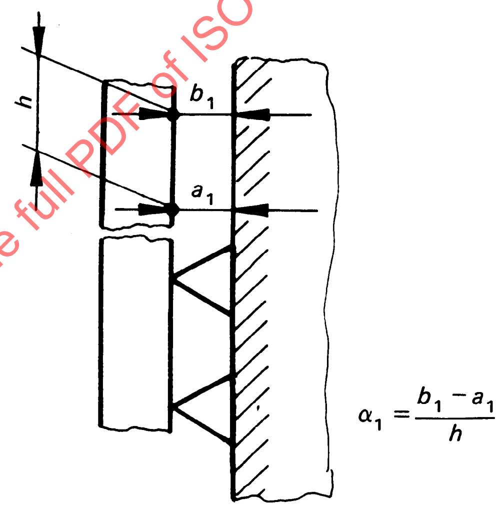

Figure 9 — Measuring arrangement with no load

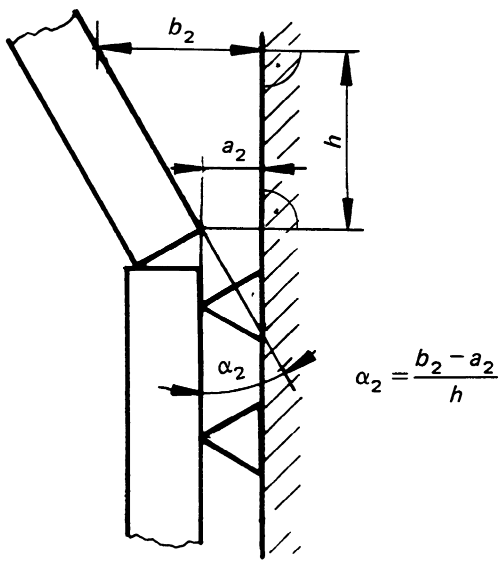

Figure 10 — Measuring arrangement with load

5.7.3.2 Measurements (see figure 10)

Using a gauge calibrated to 0,01 mm, the dimensions a_1, with no load, and a_2, with load, corresponding to the lower edge of the upper wheels, are measured.

In order to obtain the angle α, the dimension b_2 corresponding to the upper edge of the wheels is also measured, with load, using a gauge calibrated to 0,01 mm. The distance between these two measurements is h.

5.7.3.3 Expression of results

The eccentricity g, in millimetres, is given by the formula

$$g = a_1 - a_2$$

The angle α, in radians, is calculated from the formula

$$\alpha = \alpha_2 - \alpha_1$$

5.7.4 Flash and resistance butt welding machines

5.7.4.1 Measuring accessories (see figure 11)

Two bars of steel, having a sectional area equal to the maximum area which can be welded with the machine, and each fitted with a graduated scale approximately 1 m in length, are fixed in the jaws and placed in contact in such a way that the distance between the jaws is as given in 5.2.1.3. These bars are kept in position by application of a force equal to the maximum clamping force (2.3.2.3). The contact face of one of the bars should be domed (see figure 11).

5.7.4.2 Measurements (see figure 11)

Using a gauge calibrated to 0,01 mm, the dimensions b_1 with no load, and b_2 with load, are measured 1 000 mm from the plane of the contact.

5.7.4.3 Expression of results

The displacement, k, in millimetres, is given by the formula

$$k = b_2 - b_1$$

The value of k corresponds to the angle between the axis of the bars, in milliradians.

It is possible to measure b_2 and b_1 at a distance h_1 other than 1 000 mm.

In such cases, the displacement, k, is given by

$$k = \frac{b_2 - b_1}{h_1} \times 1\ 000$$

6 Insulation test

Under study.

7 Nameplates

7.1 General

Each welding machine or equipment shall bear a nameplate.

7.2 Information to be given on nameplates

The plate shall be fixed on the equipment and shall contain the information indicated in 7.3 and 7.4. In order to facilitate reading, it is advisable to subdivide the plate into four parts, separated by three heavy lines.

The upper part shall contain the name of the manufacturer and information permitting identification of the machine.

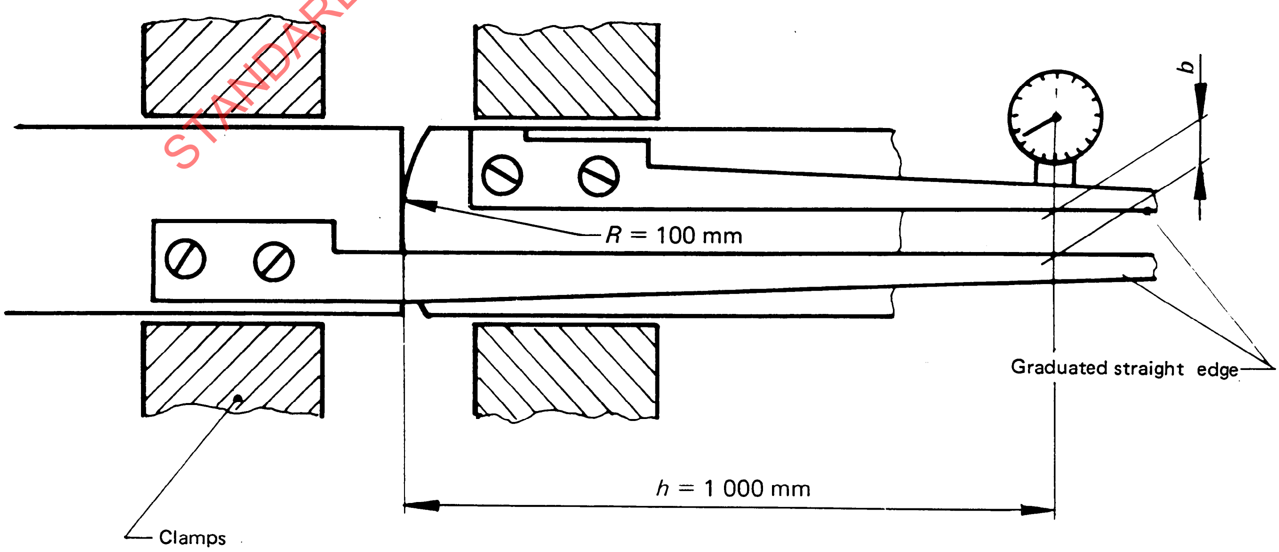

Figure 11 — Flash and butt welding machine

The second part shall indicate the supply characteristics and electrical energy requirements of the machine.

The third part shall indicate all electrical information concerning the characteristics of the welding circuit and the performance of the machine.

Finally the fourth part shall contain details of the mechanical characteristics of the equipment.

Annexes B and C give examples of such nameplates.

7.3 Plate for spot, projection and seam welding machine and complete portable equipment

The plates shall bear the following information :

1) the name of the manufacturer;

2) the type of apparatus or model as given in the list of the manufacturer;

3) the trade mark, if any;

4) the number of this International Standard;

5) the serial number of the machine. This number shall not be changed or removed when the machine is repaired;

6) the number of phases of the rated supply voltage, for example 1 for single phase machines;

7) the frequency of the rated supply voltage, in hertz;

8) the rated supply voltage, symbol U_{1n}, i.e. the mains voltage to which the equipment should be connected;

Example : 1 ~ 50 Hz U_{1n} 220 V for a single-phase machine.

9) the number of phases of the ancillary voltage;

10) the frequency of the mains voltage for supplying ancillary and control circuits, in hertz;

11) the ancillary voltage, symbol U_a, i.e. the mains voltage for supplying ancillary and control circuits;

Example : 3 ~ 50 Hz U_a 380 V for a three phase ancillary voltage.

12) the nominal power, in kilovoltamperes, at 50 % duty cycle, symbol S_n, (see 2.1.12);

13) the maximum welding power, in kilovoltamperes, symbol $S_{max.}$, according to the minimum impedance (see 2.1.11);

14) the secondary open-circuit voltage, symbol U_{20} (see 2.1.8).

This may have several different values and the lowest and highest values shall be indicated;

15) the number of values of open-circuit voltage including the lowest and the highest;

16) the maximum short-circuit secondary current, in kiloamperes, symbol I_{2cc} (see 2.1.9). Each plate shall give two values of I_{2cc} arranged in such a way as to make it obvious that the smaller of the two values corresponds to maximum impedance of the secondary circuit, and the greater one to the minimum impedance (l and e minimum);

17) the throat gap, in millimetres, symbol e (see 2.2.1). If the throat gap is adjustable, the two extreme values shall be given;

18) the throat depth, in millimetres, symbol l (see 2.2.2). If the throat depth is adjustable, the two extreme values shall be given;

19) the maximum and minimum electrode force, symbols $F_{max.}$ and $F_{min.}$, in newtons (see 2.3.1.1 and 2.3.1.2). If the throat depth l is adjustable, the values of $F_{max.}$, for the minimum and maximum throat depths shall be given;

20) the primary supply pressure, symbol p_a, in bars[1] (see 2.3.3);

21) the required rate of flow of cooling agent, symbol Q (see 2.3.5);

22) any supplementary information for seam welding machines.

The minimum and maximum linear speed, in metres per minute (m/min), or the frequency of rotation, per minute (min^{-1}), of the electrode wheels shall also be indicated, either on the nameplate or on a special plate.

7.4 Plates for butt welding machines

Plates for butt welding machines shall bear all the information given in 7.3, 1) to 18) and 21), together with the following :

1) the maximum and minimum upsetting force, in newtons, symbol $F_{1\ max.}$ and $F_{1\ min.}$ (see 2.3.2.1 and 2.3.2.2);

2) the maximum clamping force, in newtons, symbol $F_{2\ max.}$ (see 2.3.2.3);

3) the supply pressures, in bars, symbol p_{a1}, for the upsetting force, and symbol p_{a2}, for the clamping force.

1) 1 bar = 10^5 Pa.

Annex A

Notes on thermal time constants

A.1 General

A.1.1 During a cycle at periodic current, a transformer operating at permanent power S_p has the same temperature rise as if it were operating at power S and duty cycle X, as given by the general formula

$$S_p = S\sqrt{\frac{X}{100}}$$

A.1.2 Generally, energy losses are removed by water cooling. Hence, the temperature rise of the windings is proportional to the energy loss and the admissible final temperature rise depends upon the type of insulation.

The amount of heat removed during a cycle is, therefore, greater since the maximum heating occurs for the total cycle time, as in the case of a transformer on permanent duty. Similarly this will apply to a transformer on periodic duty if the thermal inertia is high.

A.1.3 If the thermal inertia is low, the temperature will vary during each cycle. The energy losses removed are then less than those considered in A.1.2 and the general formula no longer applies and must be substituted by

$$KS_p = S\sqrt{\frac{X}{100}}, \text{ or } KS_n = S\sqrt{\frac{X}{100}}$$

where K is a function of the thermal time constant and the duty factor X.

A.1.4 The thermal time constant may be expressed as the subtangent of the cooling curve. It may be measured as such or by other methods. Coefficient K is obtained from figure 12, related to the duty factor X and the ratio :

$$Y = \frac{\text{duration of the cycle}}{\text{time constant}}$$

Recent experiments have shown the time constant to be approximately 2 min.

A.2 Application for heating tests

A.2.1 Spot welding machines

A.2.1.1 In the general test (5.5.1), with a cycle of 60 s and maximum short-circuit power S_{cc}, the duty cycle X may be approximately 10 % and Y = 1/2.

From the curves, K = 90 %.

A.2.1.2 If the general test is unsuitable and the test method described in 5.5.2.1 is used, with X = 100 % and K = 1, the value of S_n measured by this method will be higher than that obtained with the general test.

To correct this, it is necessary to multiply the measured value by 0,9.

A.2.2 Seam welding machines

A.2.2.1 In the general test, with a cycle of 60 s and maximum short-circuit power S_{cc}, the duty cycle X may be approximately 40 % and Y = 1/2.

From the curves, K = 94 %.

A.2.2.2 If the general test is unsuitable and the test method described in 5.5.2.2 is used, to supply the machine at rated voltage so as not to reduce the losses in the magnetic circuit, the duration of cycle is 60 s and X = 50 %. K is then between 96 % and 100 %.

Any correction needed is practically negligible.

A.3 Other uses for the curves

The curves may be used to choose a transformer, if the duration of the work cycle is greater than the conventional 60 s.

Example : A spot welding machine supplies 15 pulses during 1 min and has a rest time of 2 min.

Welding power = 200 kVA

Welding time = 1,2 s

For each pulse, $X = \frac{15 \times 1{,}2}{60} = 0{,}3$

During this time, K = 1 and $S_p = 200\sqrt{0{,}3} = 110$ kVA.

Over a period of 3 min, the machine is effectively working for 1 min and resting for 2 min.

$$X = \frac{1}{3},\ Y = \frac{3}{2} \times 1{,}5, \text{ and } K = 81\ \%$$

$$S'_p = \frac{110}{0{,}81}\sqrt{\frac{1}{3}} = 78 \text{ kVA}$$

$$S_n = 78\sqrt{2} = 111 \text{ kVA.}$$

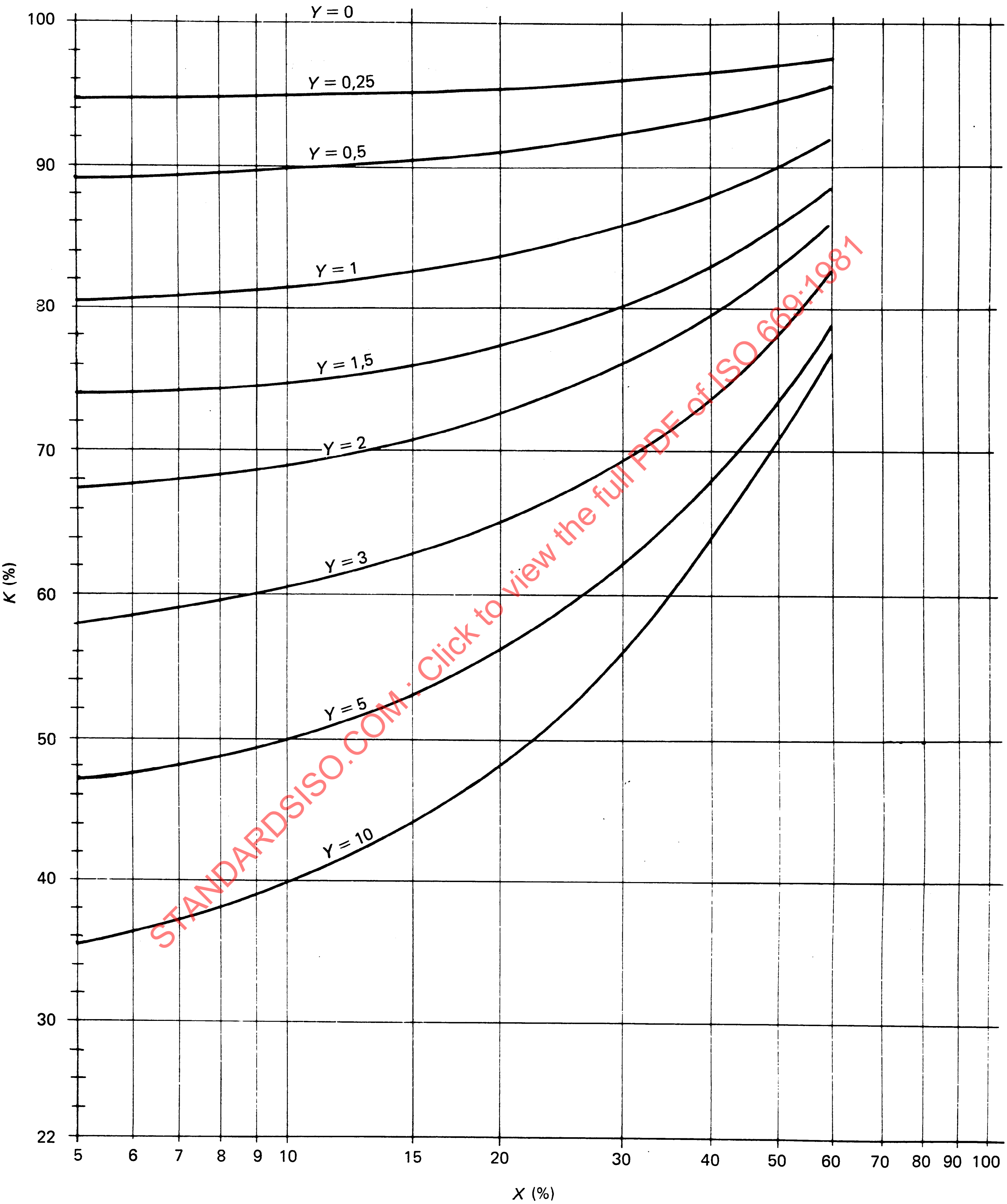

Figure 12 — Characteristics of a transformer at periodic duty cycle