

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 669

RATING OF RESISTANCE WELDING EQUIPMENT

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BRIEF HISTORY

The ISO Recommendation R 669, *Rating of resistance welding equipment*, was drawn up by Technical Committee ISO/TC 44, *Welding*, the Secretariat of which is held by the Association Française de Normalisation (AFNOR).

Work on this question by the Technical Committee began in 1957 and led, in 1963, to the adoption of a Draft ISO Recommendation.

In May 1966, this Draft ISO Recommendation (No. 974) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Ireland	Sweden
Belgium	Israel	Switzerland
Brazil	Japan	Turkey
Chile	Korea, Rep. of	U.A.R.
Czechoslovakia	Norway	United Kingdom
Denmark	Poland	Yugoslavia
Finland	Romania	
France	South Africa,	
Germany	Rep. of	
Hungary	Spain	

Six Member Bodies opposed the approval of the Draft :

Canada
India
Netherlands
Portugal
U.S.A.
U.S.S.R.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in February 1968, to accept it as an ISO RECOMMENDATION.

RATING OF RESISTANCE WELDING EQUIPMENT

PART I

GENERAL

1. SCOPE

This ISO Recommendation applies to single-phase resistance welding machines, including complete mobile equipment, but not to transformers supplied separately. Provisionally, it covers equipment whose maximum conventional power (see clause 2.8) does not exceed 400 kVA.

It applies to equipment for use under the following conditions :

- (a) *Altitude.* In the absence of any information concerning height above sea level at which the machine is intended to work in ordinary service, the altitude is assumed not to exceed 1000 m (3300 ft).
- (b) *Temperature of the cooling medium.* In the absence of any information to the contrary, it is assumed that, for water-cooled machines, the temperature of the cooling water does not exceed 25 °C at the inlet of the machine and, in the case of air-cooled machines, that none of the following limits is exceeded :
 - maximum ambient air temperature 40 °C
 - daily average ambient air temperature 30 °C
 - yearly average ambient air temperature 20 °C
- (c) *Pressure of cooling water.* In the absence of any information to the contrary, it is assumed that the pressure of the cooling water is not less than that for which the machine is designed.

2. DEFINITIONS

- 2.1 *Operating conditions.* All quantities defining the performance of a machine.
- 2.2 *Rated.* Qualifying term applied to a quantity which is used in the specification of resistance welding equipment.
- 2.3 *Duty.* A schedule of the loads on an apparatus or machine taking account of their respective duration and sequence.
- 2.4 *Periodic duty.* A duty which is repeated periodically.
- 2.5 *Duty cycle* (see Note 1). The ratio of the duration of the electrical load (see Note 2) to the duration of the complete cycle. This ratio, lying between 0 and 1, may be expressed as a percentage.

NOTES

- 1. In English, the term "duty factor", as used in the ISO and IEC definitions, and the term "duty cycle" are synonymous.
- 2. In this ISO Recommendation, the word "load" should be considered in a restricted manner. It refers to a constant load which excludes all periods of pre-heat, post-heat and slope control.

- 2.6 *Maximum short-circuit power (P_m)*. The maximum apparent power at the terminals of the machine, expressed in kilovolt-amperes, absorbed at the highest regulator setting, the electrodes being short-circuited according to conditions laid down in the methods of test (see Part II, section 1) and the machine arranged in such a manner as to have the minimum secondary impedance compatible with this method of short-circuit.
- 2.7 *Maximum welding power.** The power equal to 0.8 of the value of maximum short-circuit power.
- 2.8 *Maximum conventional power at 50 % duty cycle (P_c)**. The maximum apparent power, expressed in kilovolt-amperes, corresponding to an actual or assumed continuous service at a duty cycle of 50 % with the regulator at its highest setting without exceeding the temperature rises specified in section 4, when tested in accordance with the following recommendations:

3. CONDITIONS UNDER WHICH TEMPERATURE MEASUREMENTS SHOULD BE TAKEN

3.1 Air-cooled transformers

The test should be made at an ambient air temperature of at least $+10^\circ\text{C}$. It is assumed that the rise in temperature is the same for ambient temperatures between $+10^\circ\text{C}$ and $+40^\circ\text{C}$. The ambient temperature should be taken as the average registered during the last quarter of the test.

The rises in temperature should be measured by either the resistance or thermometer method in the case of primary windings, and by either thermometer or embedded detectors in the case of secondary windings, provided that, when using the thermometer method, the measurement is taken at the hottest accessible point.

The temperature rise should be measured immediately after the end of the last period under load.

The highest temperatures registered should be the reported values.

3.2 Water-cooled transformers

In determining the temperature rises, account should be taken of the actual water inlet temperature at the time of the test.

The water inlet temperature should be taken as the average registered during the last quarter of the test.

The temperature rise should be measured by either the resistance or embedded detector method in the case of primary windings, and by either the thermometer or embedded detector method in the case of secondary windings.

When using the resistance method the temperature should be measured with the cooling water shut off and the load removed. The readings should be taken not less than 15 seconds and not more than 60 seconds after shutdown.

When using the embedded detector method for measuring the temperature of either the primary or the secondary windings, and the thermometer method for measuring that of the secondary windings, the temperature should be measured with the cooling water flowing and the load applied.

The highest temperatures attained should be the reported values.

* See Part III. The maximum welding power is symbolized by S_{max} . The maximum conventional power at 50 % duty cycle is symbolized by S_{conv} .

4. LIMITS OF TEMPERATURE RISE

The limits of rise in temperature for air-cooled and water-cooled transformers should be in accordance with the following Table.

TABLE – Limits of temperature rise*

Cooling medium	Winding	Method of determination	Limits of temperature rise, in °C, for classes of insulation				
			A	E	B	F**	H**
AIR	Primary	Resistance	60	75	85	105	130
		Thermometer	55	70	80	100	120
	Secondary	Thermometer	55	70	80	100	120
		Embedded detector	65	80	90	115	140
WATER	Primary***	Resistance	70	85	95	115	140
		Embedded detector	75	90	100	125	150
	Secondary	Thermometer	65	80	90	110	135
		Embedded detector	75	90	100	125	150

* The values given in this Table are in accordance with the Recommendations of the International Electro-technical Commission and may be modified when those Recommendations have been modified.

** The numerical values quoted for classes F and H should be considered as tentative only and may be revised when more practical experience is available.

*** These maximum rises in temperature for primary windings apply only where there is intimate contact between these windings and the parts directly cooled by water.

PART II METHODS OF TEST

1. DETERMINATION OF MAXIMUM SHORT-CIRCUIT POWER (P_m)

1.1 General

The resistance welding machine should be brand-new. In determining the maximum short-circuit power, the rated primary voltage of the machine should be used. The supply voltage under load, measured at the terminals of the machine, should not differ by more than +5 % and -10 % from the rated voltage. Corrections should be made by the rule of proportionality of the current to the voltage.

1.2 Conditions of short-circuit

1.2.1 *Spot and seam welding machines.* The short-circuit should be effected by bringing together the electrodes, having regard to the following condition :

$$d = (0.5 \pm 0.05)\sqrt{F} \geq 2.5$$

where

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

F is the maximum force developed by the machine, expressed in kilogrammes-force.

The spot welding electrode tips should be flat.

The material of the electrodes and wheels should have a conductivity of not less than 80 % of that of standard annealed copper.*

1.2.2 *Projection welding machines.* The short-circuit should be effected by inserting between the platens, directly under the centre of the cylinder of the machine, a bar of copper, the cross-sectional area of which is adequate to prevent its overheating. The maximum clamping force should be applied to the machine.

The length l in millimetres of the copper bar between the platens should be as follows :

$$l = 0.012 F + 75$$

where F is the maximum force developed by the machine, expressed in kilogrammes-force.

Where the minimum distance attainable between the platens is greater than $(0.012 F + 75)$, then l should be equal to the minimum distance + 5 mm.

1.2.3 *Butt welding machines.* The short-circuit should be effected by inserting between the electrodes of the machine a bar of copper, the cross-sectional area of which is adequate to prevent its overheating, the contact surfaces being as large as practicable. The maximum clamping force should be applied to the machine.

The length of the copper bar should be determined by the distance L (see the Figure) separating the opposed faces of the jaws, expressed in millimetres in accordance with the following formula :

$$L = 1.5 \frac{S}{W} + 2$$

* The following resistivity laid down by the International Electrotechnical Commission (IEC Publication No. 28) is taken as the normal value for standard annealed copper :

"At a temperature of 20 °C the volume resistivity of standard annealed copper is $1/58 = 0.017241 \dots$ ohm square millimetre per metre $\left(\frac{\text{ohm} \cdot \text{mm}^2}{\text{m}}\right)$ ".

where

S is the maximum cross-sectional area of the metal which can be welded, expressed in square millimetres;

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

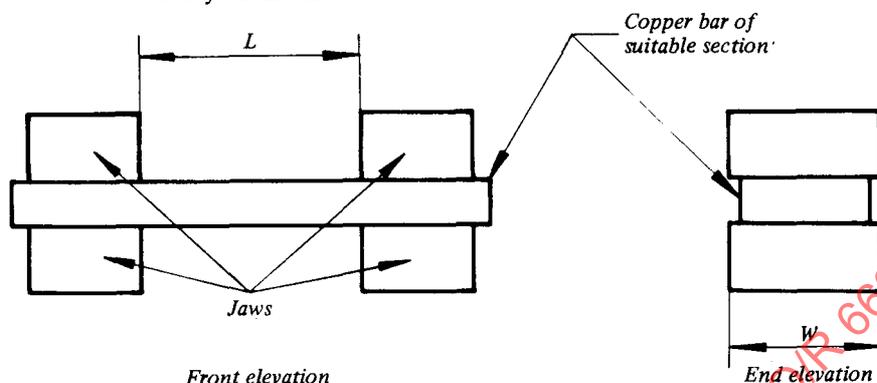


FIGURE – Short-circuiting bar for butt welding machines

2. DETERMINATION OF MAXIMUM CONVENTIONAL POWER P_c AT 50% DUTY CYCLE

With the machine setting and the supply voltage set as described in section 1, the primary power P_m should be measured as indicated in section 1, and the corresponding duty cycle X , expressed as a percentage, which the machine can withstand without exceeding the limits of temperature rise specified in section 4 of Part I should then be determined. The maximum conventional power P_c at 50% duty cycle should be calculated from the following formula :

$$P_c = P_m \sqrt{\frac{X}{50}}$$

In order to obtain the duty cycle X an adjustment should be made within the setting of a constant cycle time ($t_1 + t_2$), in accordance with the characteristics of timers and contactors, t_1 being the *current-on time* and t_2 being the *current-off time*. This means that t_1 should be increased and t_2 decreased and the cycle repeated until the temperature rises specified in section 4 of Part I are reached. However, if, at the chosen setting, the maximum value t_1 obtainable on the machine due to the timer range or control gear rating is not sufficient to produce this permissible temperature rise, then ($t_1 + t_2$) will no longer be constant and t_1 should be left on the maximum permissible setting and t_2 reduced until the appropriate temperature rise is reached. In cases where the machine is suitable, the approval test period should be 60 seconds and for other cases a shorter time can be used, for example, 6 seconds when electronic contactors are used.

The duty cycle X should be calculated from the following formula :

$$X = \frac{t_1}{t_1 + t_2} \times 100$$

In cases where the power available is not sufficient to test the machine by the method described above, the following method may be used by agreement between the purchaser and the manufacturer.

The full primary voltage should be used in conjunction with the top tapping and the secondary current reduced by means of an impedance in the secondary circuit. The load should be applied with a duty cycle of at least 50% and with a current-off time of not more than 30 seconds.

The conventional power P_c at 50% duty cycle should then be calculated as follows :

$$P_c = P_m \sqrt{\frac{X}{50}}$$

where

P_m is the measured power;

X is the duty cycle used.

When it is desired to use these formulae for determining the power and corresponding duty cycles at other settings, reference should be made to the Annex.

3. DETERMINATION OF ROOT MEAN SQUARE VALUE OF MAXIMUM SHORT-CIRCUIT SECONDARY CURRENT

The maximum short-circuit secondary current should be measured under the same conditions of test as those used in determining the maximum short-circuit power and with the same method of correction. It should be expressed as the root mean square value of the current in amperes.

Provisionally an error in measurement of $\pm 10\%$ is permitted in this determination until more accurate measuring methods are developed.

NOTE. — The product of turns 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 maximum short-circuit secondary current. This Note especially applies to the use of wrapped transformers with grain-oriented silicon steel core, if the working point lies close to the bend of the magnetizing line. In this case any small increase of the voltage may produce an important increase of the magnetizing current.

4. MEASUREMENT OF TEMPERATURE

4.1 Resistance method

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

$$\frac{t_2 + 235}{t_1 + 235} = \frac{R_2}{R_1}$$

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

$$t_2 - t_a = \frac{R_2 - R_1}{R_1} (235 + t_1) + (t_1 - t_a)$$

where

- t_2 is the temperature in degrees Celsius of the winding at the end of the test;
- t_1 is the temperature in degrees Celsius of the winding when cold or at the moment of initial resistance measurement;
- t_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 winding (cold);
- R_2 is the resistance of the winding at the end of the test.

4.2 Ambient temperature

4.2.1 Air-cooled equipment. Thermometers should be placed around the equipment at a distance of about 1 m (3 ft) and a height of about half that of the equipment. They should be protected from all heat radiation and draughts : the bulbs may be placed in small cups of oil to even out temperature variations.

4.2.2 Water-cooled equipment. The thermometers should be placed in the water supply at the inlet to the equipment.

4.3 Duration of heating tests

The tests should proceed until the rate of increase of temperature does not exceed 2 deg C per hour.

PART III

MARKING OF NAMEPLATES

The nameplate should contain at least the following information :

	Symbols
(a) Identity of maker	
(b) Type of machine	
(c) Serial number of the machine	
(d) Maximum conventional power in kilovolt-amperes at 50 % duty cycle	$S_{conv.}$
(e) Maximum welding power in kilovolt-amperes	$S_{max.}$
(f) Rated primary frequency in hertz or cycles per second	f
and number of phases*	m
(g) Rated primary voltage*	U_1
(h) Maximum short-circuit secondary current in amperes r.m.s.	$I_2 max.$
(i) Maximum force between electrodes in kilogrammes-force or pounds-force**	$F_{max.}$

* If necessary, information on the supply for ancillary circuits should be included.

** For air or hydraulically operated machines this item should be followed by the corresponding pressure of the fluid used.