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ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 635

CODE OF SYMBOLS FOR COVERED ELECTRODES
FOR ARC WELDING OF MILD STEELS
AND LOW ALLOY HIGH TENSILE STEELS

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 635, *Code of Symbols for Covered Electrodes for Arc Welding of Mild Steels and Low Alloy High Tensile Steels*, 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 1953 and led, in 1957, to the adoption of a Draft ISO Recommendation.

In September 1957, this Draft ISO Recommendation (No. 178) 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:

Bulgaria	India	Portugal
Burma	Israel	Romania
Czechoslovakia	Italy	Spain
Denmark	Japan	Sweden
Finland	New Zealand	Switzerland
France	Norway	United Kingdom
Greece	Poland	Yugoslavia

Four Member Bodies opposed the approval of the Draft.

Belgium
Netherlands
Republic of South Africa
U.S.S.R.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in November 1967, to accept it as an ISO RECOMMENDATION.

CODE OF SYMBOLS FOR COVERED ELECTRODES FOR ARC WELDING OF MILD STEELS AND LOW ALLOY HIGH TENSILE STEELS

FOREWORD

This ISO Recommendation is one of a set which also includes the following:

ISO/R 615, *Methods for Determining the Mechanical Properties of the Weld Metal Deposited by Electrodes 3.15 mm or more in Diameter,*

ISO/R 632, *Methods of Test for Determining whether an Electrode is a Deep Penetration Electrode,*

ISO/R ..., * *Special Method of Mechanical Testing to Determine the Coding for Deep Penetration Electrodes.*

INTRODUCTION

This ISO Recommendation deals with the coding of covered electrodes for the manual arc welding of mild steels and low alloy high tensile steels.

It should be noted that this Code should be considered only as a guide which may be adopted by all countries for the purpose of describing electrodes to users, more particularly by means of symbols. It is in no way designed to be a specification intended to furnish guarantees.

In order to avoid complicating the codification, it has been necessary to disregard certain special conditions existing only in a small number of countries. In spite of these imperfections however, this codification may be expected to fulfil its purpose, which is to facilitate mutual understanding among welding people of the various countries.

The codification is divided into three parts.

The first part gives a general symbol indicating the scope of the codification. The second part describes the mechanical properties of the deposited metal, by means of three symbols, and is intended for the information of designers, authorities, etc. who have to select the strength and quality required for given welds.

These first two parts give enough information for the indications which should be given in drawings, specifications, etc., while the third part, relating to welding characteristics, is of interest to welders.

More generally, in some cases, an abbreviated codification can be used, the symbols which are not used being replaced by crosses, for example.

This codification for covered electrodes should be applied by electrode manufacturers. The latter are not bound hereby to comply with requests made by users for electrodes designated by any combination whatever of symbols.

* At present Draft ISO Recommendation No. 1040.

1. GENERAL SYMBOL FOR ARC WELDING ELECTRODES AND SPECIAL SYMBOL FOR DEEP PENETRATION ELECTRODES

1.1 General symbol for covered electrodes for arc welding

E (placed at the beginning of the designation)

The letter *E* is separated from the symbols following it by a dash signifying that the electrode is for welding a mild steel or a low alloy high tensile steel. The purpose of the letter *E* is to establish a difference between the designation of arc welding electrodes and notations which may be adopted for other processes.

For instance, where the letter *E* symbol appears on drawings, it will be possible to distinguish the designation from those used for gas welding filler wire.

1.2 Special symbol for deep penetration electrodes

P (placed at the end of the designation)

The expression "deep penetration" is used for designating a type of electrode which, under the optimum operating conditions stated by the maker, can be used for welding

- (a) a close square *T* joint giving a penetration of not less than 4 mm, as measured along the joint (Fig. 1, page 5), the gap between the plates not exceeding 0.25 mm and the thickness of the plates being at least equal to twice the diameter of the electrode core wire *d*, and/or
- (b) a close square butt joint performed in two runs (one on each side of the joint), the joint thus obtained presenting no lack of penetration, and the thickness of the plates being at least equal to twice the diameter of the electrode core wire *d* plus 2 mm, i.e. $2d + 2$ mm, with a gap between the plates not exceeding 0.25 mm (Fig. 2, page 5).

2. SYMBOLS RELATIVE TO THE MECHANICAL PROPERTIES OF THE DEPOSITED METAL

2.1 Tests on the deposited metal

In order to make possible a code of symbols based upon comparable figures, the tests on the deposited metal should be carried out and interpreted under the conditions specified in ISO Recommendation R 615, *Methods for Determining the Mechanical Properties of the Weld Metal Deposited by Electrodes 3.15 mm or more in Diameter*.

ISO Recommendation R 615 specifies that the mechanical tests should be carried out at a temperature of 20 ± 2 °C in temperate climates and 27 ± 2 °C in tropical climates. It also states all the necessary requirements under which the metal should be deposited, and how the test pieces should be selected.

2.2 Symbolization of results

In selecting a symbol for each of the mechanical properties, the symbol corresponding to the lowest of the values obtained by testing all sizes of the electrode should be taken from the Tables given below.

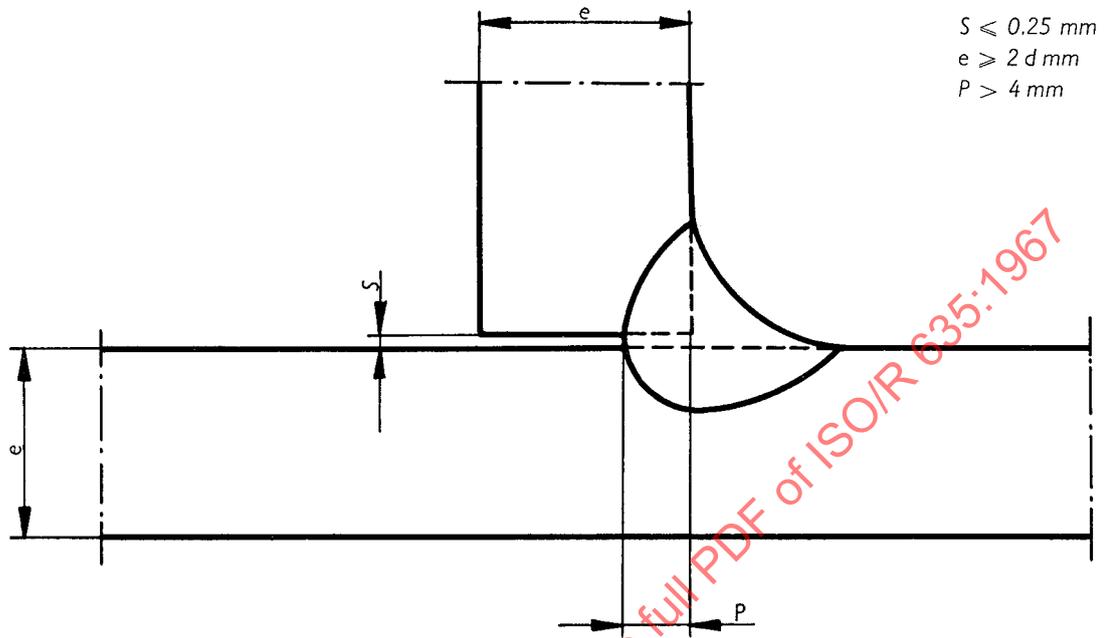


FIG. 1. — Fillet weld

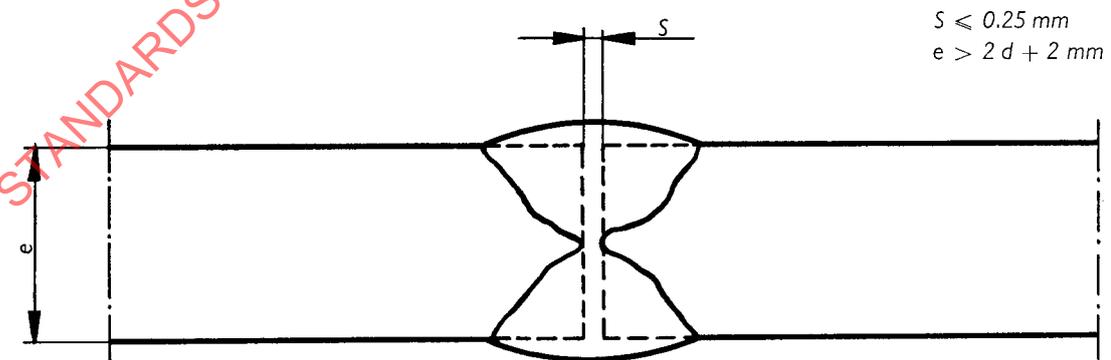


FIG. 2. — Butt weld

2.2.1 Tensile strength (minimum)

As the tensile strength of the deposited metal may vary between one diameter and another of a given electrode it is specified that the highest value of this property should not exceed the minimum tensile strength indicated by the symbol for that electrode by more than 10 kgf/mm² (6.5 tonf/in²).

The type of test piece to be used is a proportional test piece of circular cross-section conforming to ISO Recommendation R 82, *Tensile Testing of Steel*, and with a diameter of 10 mm.

TABLE 1. — Tensile strength

Symbols	kgf/mm ²	lbf/in ²	tonf/in ²
0 *	—	—	—
1	41	58 000	26
2	44	63 000	28
3	48	69 000	30.5
4	52	74 000	33
5	56	80 000	35.5
6	60	85 000	38

* The symbol 0 is used when no minimum value can be given for tensile strength.

2.2.2 Elongation (minimum)

TABLE 2. — Elongation

Symbols	Elongation * %
0 **	—
1	14
2	18
3	22
4	26
5	30

* To determine elongation, the original gauge length should be taken as $L_0 = 5.65 \sqrt{S_0}$, where S_0 is the original cross-sectional area of the gauge length, expressed in square millimetres.

** The symbol 0 is used when no minimum value can be given for elongation.

2.2.3 Impact strength KV (minimum)

The test piece to be used is the type with V-notch complying with ISO Recommendation R 148, *Beam Impact Test (V-notch) for Steel*.

TABLE 3. — Impact strength

Symbols	Impact strength kgf.m
0 *	not specified
1	3
2	6
3	9
4	12
5	15

* The symbol 0 is used when no minimum value can be given for impact strength.

3. SYMBOLS RELATING TO WELDING CHARACTERISTICS

The third part of the codification comprises three symbols indicating the type of covering, the welding positions and the conditions of electrical supply.

3.1 Type of covering

The type of covering is symbolized by one of the following letters:

<i>A</i>	=	Acid
<i>B</i>	=	Basic
<i>C</i>	=	Cellulosic
<i>O</i>	=	Oxidizing
<i>R</i>	=	1st rutile type
<i>T</i>	=	2nd rutile type
<i>V</i>	=	Other types

These designations should be understood as follows:

3.1.1 *Covering of the acid type: Symbol A*

Electrodes of the acid type have a medium or thick covering and produce an iron oxide/manganese oxide/silica slag, the metallurgical character of which is acid. The covering contains, besides oxides of iron and/or manganese, a fairly high percentage of ferromanganese and/or other deoxidizers. The slag solidifies in a characteristic honeycomb structure and is easily detached.

This type of electrode usually has a high fusion rate and may be used with high current intensities. Penetration can be good, particularly if the covering is thick. These electrodes are most suitable for welding in the flat position but can also be used in other positions. Either direct or alternating current can be employed. With this type of electrode the weldability of the parent metal should be good, as otherwise hot cracks may occur. Susceptibility to hot cracking is more particularly marked in horizontal-vertical, or vertical, fillet welds when the carbon content exceeds 0.20% in the case of killed steels and 0.25% in the case of rimming steels, and when the sulphur content exceeds 0.05% in killed steels and 0.06% in rimming steels.

The mechanical properties are good and this type of electrode is particularly suitable for welds which are to be subjected to a fairly strict radiographic inspection.

3.1.2 *Covering of the basic type: Symbol B*

Electrodes of the basic type usually have a thick covering containing considerable quantities of calcium or other basic carbonates and fluorspar so that metallurgically they are basic in character. There is a medium quantity of compact slag, which often has a brown to dark-brown colour and a glossy appearance. It is easily detached, and as it rises to the surface of the weld very quickly, slag inclusions are not likely to occur. This type of electrode gives an arc of average penetration, and is suitable for welding in all positions. Direct current of positive polarity is usually preferable, but there are some electrodes of this type which can be used with alternating current.

As the deposited metal is usually highly resistant to hot and cold cracking, these electrodes are particularly suitable for welding heavy sections and very rigid mild steel structures. They are also recommended for welding low alloy steels, and steels the carbon and sulphur contents of which are higher than those of mild steel of good weldable quality. The mechanical properties of the deposited metal are excellent, its impact strength being particularly high, even at temperatures below 0 °C.

In order to avoid porosity, the coverings of these electrodes should be very dry. As the coverings are usually hygroscopic, basic electrodes should be stored in a very dry place or, if they have already absorbed moisture, should be dried before use. This ensures that the deposited metal will have a low hydrogen content, and there is less risk of under-bead cracking when welding steels likely to show a marked hardening in the heat-affected zone.

3.1.3 *Covering of the cellulosic type: Symbol C*

The covering of electrodes of the cellulosic type is generally of average thickness and contains a large quantity of combustible organic substances, so that the decomposition of the latter in the arc produces a voluminous gas shield. The amount of slag produced is small and is easily detached.

This type of electrode is characterized by a highly penetrating arc and fairly high fusion rate. Spatter losses are fairly large and the weld surface is somewhat coarse, with unevenly spaced ripples. These electrodes are usually suitable for welding in all positions. Direct current of positive polarity, or alternating current may be used. The mechanical properties of the deposited metal are fairly good.

3.1.4 *Covering of the oxidizing type: Symbol O*

Electrodes of the oxidizing type have a thick covering composed mainly of iron oxides with or without manganese oxides. The covering gives an oxidizing slag, so that the deposited metal contains only small amounts of carbon and manganese. The slag is heavy, compact and often self-detaching. This type of electrode gives a poor penetration, a fluid molten pool and is particularly suitable when only a light run is required. It may be used with direct or alternating current, but usually its use is restricted to welding in the horizontal-vertical fillet weld and flat fillet weld positions.

The mechanical properties of the deposited metal are rather low, and these electrodes are used mainly for mild steels when the appearance of the weld is more important than the mechanical strength of the joint.

3.1.5 *Covering of the 1st rutile type: Symbol R*

First rutile type electrodes have medium or thick covering containing a large quantity of rutile or compounds derived from titanium oxide. The slag is dense and fairly viscous.

Their arc stability is good and they normally produce very little spatter. They are suitable for welding in all positions and can be used with either direct or alternating current. The susceptibility to hot cracking, particularly in vertical welds, is about the same as that of the acid type electrodes, so that the same precautions should be taken with regard to the composition of parent metal.

The mechanical properties of the deposited metal are good, and this type of electrode is used for a wide range of constructional work.

3.1.6 *Covering of the 2nd rutile type: Symbol T*

The covering of 2nd rutile type electrodes is usually of average thickness similar to that of the 1st rutile type, but produces a much more fluid and less dense slag.

These electrodes are particularly suitable for welding in the vertical and overhead positions, in which they give fillet welds less convex in appearance than those of the 1st rutile type. They can be used with direct current, or with alternating current even at fairly low open-circuit voltages.

The susceptibility to hot cracking is the same as that of the 1st rutile type.

The mechanical properties of the deposited metal are good and, in some cases, slightly better than those obtained with electrodes of the 1st rutile type.

3.1.7 *Other types of covering: Symbol V*

The symbol *V* is used to designate a covering other than one of those specified under symbols *A, B, C, O, R* and *T*.

Electrodes with coverings containing iron powder or other materials which would not affect the characteristics specified for the types of covering defined above, however, should be classified under those types and not under symbol *V*.

3.2 **Welding positions**

The symbols to be used for designating the general welding positions for which an electrode is suitable are as follows:

- 1 — All positions
- 2 — All positions, except vertical by the downwards method
- 3 — Flat butt weld, flat fillet weld, horizontal-vertical fillet weld
- 4 — Flat butt weld, flat fillet weld.

The sketches below clarify the terminology used.

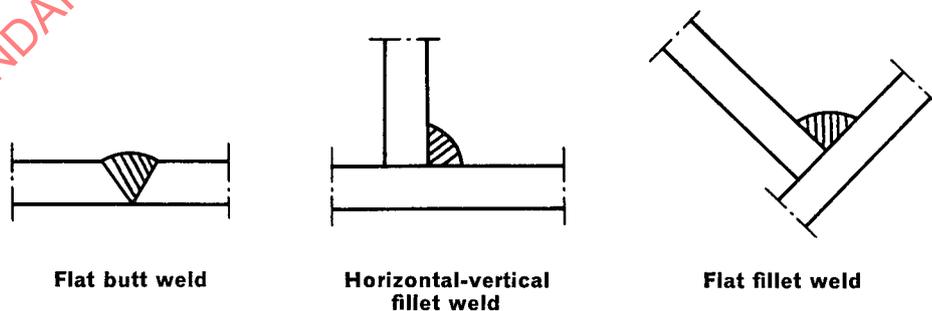


FIG. 3. — Types of weld