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Copper and copper alloys — Reverse bend testing of wire

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FOREWORD

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It has been approved by the Member Bodies of the following countries :

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No Member Body expressed disapproval of the document.

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Copper and copper alloys — Reverse bend testing of wire

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the method for the reverse bend testing of copper and copper alloy wire having a diameter or thickness equal to or greater than 0,3 mm (0.012 in) up to and including 8 mm (0.31 in).

2 PRINCIPLE

The test consists of repeated bending through 90° in opposite directions, of a test piece held at one end, each bend being over a cylindrical surface of a specified radius. The process is carried out until a specified number of bends have been made, or until failure of the test piece occurs.

The test is carried out at ambient temperature unless otherwise specified.

3 SYMBOLS AND DESIGNATIONS

No.	Symbol	Designation
1	d	Diameter of round wire
2	a	Distance between gripping faces of supports when testing wires of non-circular section
3	r	Radius of cylindrical supports
4	h	Distance from top of supports to bottom face of guide
5	y	Distance from the plane defined by the axes of the cylindrical supports to the nearest point of contact with the test piece
6	x	Distance of the axis of rotation of the operating handle from the plane defined by the top of the cylindrical supports
7	z	Clearance between the test piece and each cylindrical support
8	N_b	Number of reverse bends

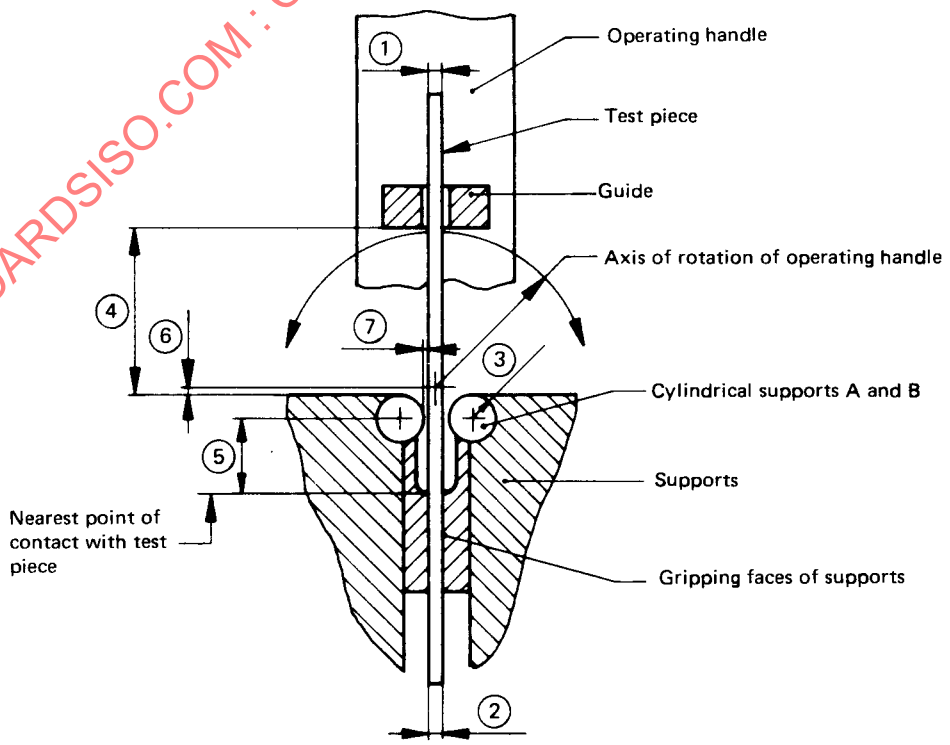

FIGURE 1 — **Reverse bend testing of copper and copper alloy wire**

4 TEST PIECES

4.1 The test piece, consisting of a piece of wire, shall preferably be straight before testing, but it may be curved in the plane in which the test bends are to be made.

4.2 If straightening is necessary, it shall be done by hand or, if this is not possible, by using a wooden, hide or similar soft hammer.

5 PROCEDURE

5.1 Hold one end of the test piece between two supports of hardened steel, each of which is rounded to the specified radius as shown in Figure 1. Bend the protruding portion of the test piece through 90° over support A, and then bring it back to its original position. Then bend it in the same plane in the reverse direction over support B, and again return it to its original position[1]. Repeat this procedure as often as specified or necessary to produce failure.

5.2 One bend consists of bending a test piece through an angle of 90°, and then returning it to its original position (see Figure 2).

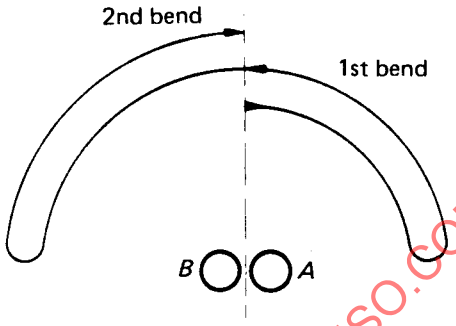

FIGURE 2 — **Method of counting reverse bends**

5.3 Bending shall be at a rate such that the heating does not affect the results of the test, but the rate shall not exceed one bend per second, unless a faster rate is permitted by the material specification.

5.4 To ensure contact of the test piece with the supports, a tensile load not exceeding the equivalent of 2 % of the nominal tensile strength of the wire may be applied during bending.

5.5 The axes of the cylindrical supports are to be parallel. A plane determined by the axes of the cylindrical supports shall be perpendicular to the direction of the axis of the test piece.

5.6 The clearance, z, between the test piece and each cylindrical support shall be approximately 0,1 mm.

5.7 The distance, y, from the plane defined by the axes of the cylindrical supports to the nearest point of contact with the test piece shall be, in the case of cylindrical supports with $r \leqslant 2{,}5$ mm, approximately 1,5 mm, and in all other cases approximately 3 mm.

5.8 The distance, x, of the axis of rotation of the operating handle from the plane defined by the top of the cylindrical supports shall be approximately 1 mm.

5.9 The radius, r, of the cylindrical supports is dependent on the nominal diameter of wire and shall be as follows (see the Annex) :

Dimensions in millimetres

Nominal diameter of wire d		Radius of supports r
over	up to	
0,3*	0,5	1,25 ± 0,05
0,5	0,7	1,75 ± 0,05
0,7	1,0	2,5 ± 0,1
1,0	1,5	3,75 ± 0,1
1,5	2,0	5 ± 0,1
2,0	3,0	7,5 ± 0,1
3,0	4,0	10 ± 0,1
4,0	6,0	15 ± 0,1
6,0	8,0	20 ± 0,1

* 0,3 mm is included.

NOTE — If supports having radii other than those listed in the table are used, they should preferably be chosen according to the graph in the Annex.

5.10 The distance from the top of the supports to the bottom of the guides where it is adjustable shall not exceed 75 mm, and shall in any case be small enough to force the test piece into contact with each support through 90° without twisting or kinking.

6 TEST RESULTS

6.1 The criterion of the end of a test and the interpretation of the results are matters for the specification of the product being tested.

6.2 The test report shall state the number of reverse bends after which the test piece is deemed to have failed or it shall state that the test piece has withstood the specified number of reverse bends.

1) This description of the procedure is not intended to imply that the test piece shall be brought to rest after each complete bend as defined in 5.2.

ANNEX

RELATIONSHIP BETWEEN RADIUS OF SUPPORTS AND NOMINAL DIAMETER OF WIRE

To achieve reasonable discrimination among test results, the radius of the supports is chosen so that the nominal bending strain ϵ in the wire at the outside of the bend is not greater than that corresponding to the line OA, nor generally less than that corresponding to the line OB in the graph below.

For this purpose the strain at the outside of the bend may be taken as :

$$\epsilon = \frac{d}{2R} \times 100\ \% \quad \text{where} \quad R = r + \frac{d}{2}$$

The values of r tabulated in 5.9 and shown on the graph, and the corresponding maximum values of d have been selected arbitrarily to give $r = 2{,}5\,d$.

The line OA therefore represents a strain of 16,6 %. Similarly OB (drawn through points where $r = 3{,}75\,d$) represents a strain of 11,8 %.

For tests of ductile materials the strain ϵ shall be between these limiting values. For less ductile materials, support radii shall be agreed to give values of ϵ equal to half those indicated by the graph.