



February 2012

SPECIFICATION SS-139/1
SEAMLESS ELECTROLYTIC COPPER ROUND TUBES
FOR BUS BARS AND BUS CONNECTIONS

I. SCOPE

This Specification covers the manufacture and testing of seamless electrolytic copper round tubes to be used as bus bars and bus connections in the Stations and Substations outdoor switchyards.

II. MANUFACTURE REQUIREMENTS

1. Tubes include hollow products of round cross-section having a continuous periphery and uniform wall thickness as specified below.
2. The material shall be electrolytic copper and cold drawn to size.
3. Tubes shall be finished by such cold working to produce the required temper (hard drawn - see physical characteristics of Table 1).
4. Copper tubes shall be furnished in lengths of 6m.

III. PHYSICAL AND ELECTRICAL REQUIREMENTS

1. The material shall conform to the requirements as to Brinell hardness and electrical resistivity as prescribed in Table 1.
2. Tension elongation and bend tests shall be made as stated below.

TABLE 1

SEAMLESS ELECTROLYTIC COPPER ROUND TUBES

External Diameter (mm)	Internal Diameter (mm)	Thickness (mm)	Tolerance for External Diameter (mm)	Tolerance for Thickness (%)	Minimum Tensile Breaking Strength (kg/mm ²)	Minimum Elongation Breaking (%)	Minimum Hardness (Brinell) (kg/mm ²)	Maximum Electric Resistivity at 20°C (Ω mm ² /m)
20	16	2	± 0.10	± 9	28	5	60	0.0179
30	26	2	± 0.15	± 9	28	5	60	0.0179
30	24	3	± 0.15	± 9	28	5	60	0.0179
60	52	4	± 0.20	± 9	28	5	60	0.0179
80	70	5	± 0.20	± 9	28	5	60	0.0179

IV. TESTS

All tests shall be made in the manufacturer's laboratory or another official laboratory upon agreement between Purchaser and Seller. Specified tests shall be followed by the IPTO representative.

All tests specimens shall be tested in full size and shall not show gassing or open-grain structure characteristics of embrittlement. One specimen shall be selected from each size of specified tubes.

Detailed test reports for the tests below are to be supplied by seller.

1. **Bend Test**

The specimen shall stand being bent cold through a 90° angle without fracture on the outside of the bent portion.

Tubes shall be bent around the smallest standard mandrel-size having a radius equal to, or greater than four times the outside diameter of the tube. Tube specimen may be filled with sand.

2. **Brinell Hardness Test**

It consists in measuring the diameter of the hollowness made by a steel ball under a load equal to: $P = 500\text{kg}$ where D = ball diameter in equal to 10mm. The hardness is calculated from the following formula:

$$H = \frac{2P}{\pi D(D - \sqrt{D^2 - d^2})}$$

where: D = ball diameter (in mm.)

P = applied load as specified above.

d = hollowness diameter in mm.

and it is expressed in Brinell degree.

3. **Tension Test**

Test specimens of full size tubular sections are to be used. Snug-fitting metal plugs shall be inserted far enough in the ends of such tubular specimens to permit the testing machine jaws to grip the specimens properly. The plugs shall not extend into that part of the specimen upon which the elongation is measured. The tensile breaking strength as well as the percent elongation are to be determined for the tested tubes.

Procedure for testing the specified tubes in tension, shall be according either with DIN standards or with A.S.T.M. standards (EG-46 "TENSION TESTING OF METALLIC MATERIALS").

4. **Electrical Resistivity Test**

The volume resistivity of a specimen at least 30 cm. long is to be measured with a Kelvin-type double bridge or a potentiometer, the surface in contact with the test specimen being a substantially sharp knife edge.

The test specimen shall be of uniform cross section throughout its length within plus and minus 0.75 percent (0.75%) of the cross sectional area. It shall have resistance of at least 10 micro-ohms in the test length between

potential contact. It shall have no surface cracks or defects visible to the unaided normal eye and substantially free from surface oxide dirt and grease.

With reference to the "Procedure", "Temperature Correction" and "Report" for the present test, see A.S.T.M. standards B-193-49 "RESISTIVITY OF ELECTRICAL CONDUCTOR MATERIALS".

V. DIMENSIONS - TOLERANCES

Dimensions and tolerances are given in Table 1.

VI. FINISH

The material shall be free of all imperfections not consistent with the best commercial practice and shall be commercially bright and clean.

VII. DATA TO BE SUPPLIED BY BIDDER

1. Test report for all specified tests.
2. Weight in kg per linear meter, of each kind of copper tubes.