

**PUBLIC POWER CORPORATION**ATHENS - GREECE

April 1968

**SPECIFICATION SS-17/1****HARD DRAWN COPPER CONDUCTORS  
FOR SUBSTATION OVERHEAD BUSBARS****I. SCOPE**

This Specification covers the design requirements, materials and test procedure for Hard Drawn Copper Conductors. The term corporation whenever used in this Specification shall mean and refer to the Public Power Corporation.

**II. STANDARD OF CONSTRUCTION AND TESTING**

The copper conductors shall meet the requirements of the latest revision of ASTM B-8 for class AA conductors.

Before stranding the copper wire used shall meet all the requirements of the latest revision of specification ASTM B-1 "Hard Drawn Copper Wire".

Any deviations from the designated standard and test shall be described in detail in the bid, together with the reasons for such deviations.

Where the requirements of this specification in respect of any features of design, construction or performance are in conflict with the designated standards, this specification shall prevail.

**III. SIZES**

The Conductors shall consist of a number of individual strands laid up on the Concentric Right-hand Lay System and shall preferably be of the following sizes:

| Nominal Size<br>(sq. mm) | Preferred Stranding | Resistance<br>( $\Omega$ /km at 20°C) |
|--------------------------|---------------------|---------------------------------------|
| 95                       | 19                  | 0.196                                 |
| 120                      | 19                  | 0.156                                 |
| 185                      | 37                  | 0.0995                                |
| 240                      | 61                  | 0.0756                                |
| 300                      | 61                  | 0.0614                                |
| 400                      | 61                  | 0.0456                                |
| 500                      | 61 or 91            | 0.0374                                |
| 600                      | 91                  | 0.0300                                |

The lay of the conductor stranding has been assumed as 11 to 14 times the overall diameter of the conductor.

#### IV. **CONDUCTIVITY**

The conductivity of any length of conductor shall be not less than 97% of I.A.C.S. and shall be taken as the average conductivity of the individual component strands. The individual strands shall have not less than 96.5% conductivity.

#### V. **ELECTRICAL TESTS**

The electrical resistance of solid conductors shall be determined with an error not exceeding 0.1% by test on samples of adequate length to ensure the required accuracy with the particular method used.

If requested by the Corporation, certificates testifying the accuracy of the apparatus shall be provided by the Bidder, and either party concerned shall have the right to satisfy themselves that the apparatus and method of test are correct.

The measured resistance shall be corrected to the standard temperature of 20°C and to standard weight. The factor for correction to standard weight shall be the fraction Standard weight per kilometer divided by weight per kilometer of the test sample.

The measured resistance of the finished stranded conductor shall be not more than 2% greater than that specified in Clause III of this Specification. The sum of the conductance of the individual strands may be considered as the conductance of the finished conductor.

#### VI. **ULTIMATE STRENGTH AND ELONGATION**

The ultimate strength and elongation of the individual strands tested shall be determined separately in a standard tensile testing machine before stranding.

The ultimate elongation of individual wires shall be measured over a gauge length of 25cm (between gauge marks on the wire itself, not between grips, the fracture being between the points of measurement) shall be not less than shown in the following table.

The average ultimate tensile strength of the individual copper wires tested for any length of conductor, and the minimum of any wire tested shall be not less than shown in the following table:

| Copper Wire Diameter<br>(mm) | Tensile Strength of Individual Wires<br>(kg per sq.mm) |         | Min. Elongation at fracture of Individual Wires<br>(% in 25cm) |
|------------------------------|--------------------------------------------------------|---------|----------------------------------------------------------------|
|                              | Average                                                | Minimum |                                                                |
| 1.5 - 2.0                    | 46                                                     | - 44.5  | 0.8                                                            |
| 2.0 - 2.5                    | 45                                                     | - 44    | 1.0                                                            |
| 2.5 - 3.0                    | 44.5                                                   | - 43    | 1.0                                                            |
| 3.0 - 3.5                    | 44                                                     | - 42    | 1.0                                                            |

The ultimate strength of the completed Conductor shall be taken as the sum of the ultimate strengths of the copper wires at the minimum average values.

For testing the ultimate strength of finished Conductor, the manufacturer's mechanical dead ends shall be used and, when tested on lengths of cable not less than 12 meters shall develop not less than ninety five percent (95%) of the ultimate tensile strength of the complete Conductor as covered by these Specifications, before fracturing any strand.

**VII. STRANDS**

Each copper strand shall be free from scratches, die marks and surface imperfections and its section shall approximate a true circle so that its major diameter shall not exceed its minimum diameter by more than two percent (2%).

**VIII. LENGTH OF EACH PIECE**

The "Standard Length" of each piece should be approximate. The allowable tolerance shall be plus or minus five percent (5%).

Not more than seven percent (7%) of the total weight of any one item of conductor may be furnished in random lengths, none of which shall be less than fifty percent (50%) of the standard length.

The manufacturer must undertake that no random length will be wound on the same reel with a standard length and that all reels will be properly marked showing number of pieces and length of each piece.

**IX. SPLICES**

No joints shall be made in the component wires of stranded conductors in the case of conductors having 7 strands or less.

In the case of conductors containing more than 7 strands, joints either hard soldered or welded, will be permitted in the finished individual wires, provided that no two joints in the stranded conductors occur at points closer together than 15 meters.

**X. REELS**

The Conductor shall be shipped on substantial wood reels with maximum weight 2.2 ton. Reel heads shall be approximately 5cm in thickness, firmly bolted to the drum and shall be equipped with a cast iron hub bushing with a hole at the center of the head at least 7cm in diameter. Reels shall be lagged with wood lagging.

**XI. INSPECTION AND TESTS**

All equipment and / or material shall be subject to inspection and must not be shipped without release from Corporation's Representative. Release of material shall not release the manufacturer from responsibility for furnishing material to conform to requirements of the order nor invalidate any claim which Corporation may take because of defective or unsatisfactory material. The conductor manufacturer and his subcontractors shall provide adequate facilities to the Corporation's representative to test and inspect the manufacture and packing of all equipment and / or materials.

The manufacturer shall inform the Corporation of progress of the work in his shops, and shall advise him as to expected dates for completion, to the end that progress of work is clearly indicated and so that inspection and the witnessing of tests may be scheduled without delay. Copies of manufacturer's test reports shall be furnished to Corporation as requested. These reports shall be certified as correct by responsible representative of the manufacturer.

## **XII. TESTS AT MANUFACTURER'S WORKS**

### **a. Place and Manner of Test**

All tests shall be made at the manufacturer's works, and the manufacturer will furnish to the Corporation's representative, for the purpose of making such tests, one standard conductivity bridge, one standard tensile testing machine, and for tests on completed Conductor, one horizontal testing machine, and the required facilities for the use of these instruments.

All tests to determine whether the Conductor complies with these Specifications shall be made under the direction of the Corporation's representative after notice from the manufacturer to the Corporation that the material is ready to test, and the cable shall be accepted or rejected by the Corporation prior to shipment of the material from the Manufacturer's works.

Tests in the frequency indicated herein shall be made at the manufacturer's expense. Should any sample fail to meet specification, the Corporation may call for more frequent tests entirely at manufacturer's expense including the cost of the tests and full value for the material used in such tests.

### **b. Samples for Test**

Samples of individual wires for test will normally be taken before stranding. Samples shall be taken from not less than twenty percent (20%) of the spools.

If desired by the Corporation's representative, samples of individual wires for test may be taken after stranding. If so, they shall be obtained by cutting 1,40 meter lengths from the outer end of the finished Conductor on not more than five percent (5%) of the finished reels.

Samples taken after stranding shall be cut off in the presence of the Corporation's representative, who shall take possession of the samples and test them as herein before described.

If desired by the Corporation, samples for test of completed Conductor with manufacturer's standard dead end devices may be obtained by cutting 15 meters lengths from the outer end of the finished Conductor on not more than five percent (5%) and not to exceed ten percent (10%) of the finished reels.

## **XIII. INFORMATION TO BE FURNISHED BY BIDDER**

The following information shall be included in the bid:

### **a. Actual cross section of finished conductor.**

- b. Weight of finished conductor in kg. per km.
- c. Length of lay.
- d. Manufacturing length of finished conductor in meters.
- e. Number of conductor lengths packed on each shipping reel.
- f. Net total weight of conductor on each shipping reel.
- g. Dimensions (diameter and overall width) of shipping reels in meters.

JM/ab/6.4.1968