



## Standard Specification for Soft or Annealed Copper Wire<sup>1</sup>

This standard is issued under the fixed designation B 3; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This specification has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.*

### 1. Scope

1.1 This specification covers drawn and annealed or soft round bare copper wire for electrical purposes (Explanatory Note 1).

1.2 The SI values for density and resistivity are to be regarded as the standard. For all other properties the inch-pound values are to be regarded as the standard and the SI units may be approximate.

1.3 The hazard statement applies only to Section 6, Test Methods, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

2.1 The following documents of the issue in effect at the time of reference form a part of this specification to the extent referenced herein:

#### 2.1.1 ASTM Standards:

B 49 Specification for Copper Redraw Rod for Electrical Purposes<sup>2</sup>

B 193 Test Method for Resistivity of Electrical Conductor Materials<sup>3</sup>

B 258 Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors<sup>3</sup>

2.1.2 National Institute of Standards and Technology:  
NBS Handbook 100—Copper Wire Tables<sup>4</sup>

### 3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

3.1.1 Quantity of each size,

3.1.2 Wire size: diameter in inches (see 5.4 and Table 1),

3.1.3 Type of copper, if special (Section 4),

3.1.4 Package size (see 10.1),

3.1.5 Special package marking, if required, and

3.1.6 Place of inspection (see 9.1).

3.2 In addition, Supplementary Requirements shall apply only when specified by the purchaser in the inquiry, contract, or purchase order for direct procurement by agencies of the U.S. Government (S1, S2, and S3).

### 4. Materials and Manufacture

4.1 The material shall be copper of such quality and purity that the finished product shall have the properties and characteristics prescribed in this specification.

NOTE—The following standards define the materials suitable for use: Specification B 49.

4.2 Copper bars of special qualities, forms, or types, as may be agreed upon between the manufacturer and the purchaser, and which will conform to the requirements prescribed in this specification may also be used.

### 5. General Requirements (see Section 7)

5.1 *Tensile Strength and Elongation*—The wire shall conform to the requirements for elongation prescribed in Table 1 (Explanatory Note 2). No requirements for tensile strength are specified. For wire whose nominal diameter is more than 0.001 in. (1 mil) (0.025 mm) greater than a size listed in Table 1, but less than that of the next larger size, the requirements of the next larger size shall apply.

5.2 *Joints*—Necessary joints in the completed wire and in the wire and rods prior to final drawing shall be made in accordance with the best commercial practice.

5.3 *Resistivity*—The electrical resistivity 20°C shall not exceed 875.20  $\Omega \cdot \text{lb}/\text{mile}^2$ .

5.4 *Dimensions and Permissible Variations*—The wire sizes shall be expressed as the diameter of the wire in decimal fractions of an inch to the nearest 0.1 mil (0.0001 in.) (0.0025 mm) (Explanatory Note 3). For diameters under 0.0100 in. (0.2540 mm), the wire shall not vary from the specified diameter by more than plus and minus 0.1 mil (0.0001 in.), and for diameters of 0.0100 in. and over the wire shall not vary from the specified diameter by more than plus and minus 1%, expressed to the nearest 0.1 mil (0.0001 in.).

5.5 *Finish*—The wire shall be free of all imperfections not consistent with the best commercial practice.

### 6. Test Methods

6.1 *Tensile Strength and Elongation*—No test for tensile strength shall be required.

6.1.1 Determine the elongation of wire whose nominal diameter is larger than 0.0808 in. (2.052 mm) in diameter as the permanent increase in length, expressed in percent of the original length, due to the breaking of the wire in tension,

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<sup>2</sup> Annual Book of ASTM Standards, Vol 02.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 02.03.

<sup>4</sup> Available from the National Technical Information Service, 5285 Port Royal Rd, Springfield, VA 22161.

TABLE 1 Tensile Requirements

| Diameter |        | Area at 20°C |                 |                 | Elongation in<br>10 in.<br>(254 mm),<br>% min |
|----------|--------|--------------|-----------------|-----------------|-----------------------------------------------|
| in.      | mm     | cmils        | in <sup>2</sup> | mm <sup>2</sup> |                                               |
| 0.4600   | 11.684 | 211 600      | 0.1662          | 107.0           | 35                                            |
| 0.4096   | 10.404 | 167 800      | 0.1318          | 85.0            | 35                                            |
| 0.3648   | 9.266  | 133 100      | 0.1045          | 67.4            | 35                                            |
| 0.3249   | 8.252  | 105 600      | 0.08291         | 53.5            | 35                                            |
| 0.2893   | 7.348  | 83 690       | 0.06573         | 42.4            | 30                                            |
| 0.2576   | 6.543  | 66 360       | 0.05212         | 33.6            | 30                                            |
| 0.2294   | 5.827  | 52 620       | 0.04133         | 26.7            | 30                                            |
| 0.2043   | 5.189  | 41 740       | 0.03278         | 21.2            | 30                                            |
| 0.1819   | 4.620  | 33 090       | 0.02599         | 16.8            | 30                                            |
| 0.1620   | 4.115  | 26 240       | 0.02061         | 13.3            | 30                                            |
| 0.1443   | 3.665  | 20 820       | 0.01635         | 10.5            | 30                                            |
| 0.1285   | 3.264  | 16 510       | 0.01297         | 8.37            | 30                                            |
| 0.1144   | 2.906  | 13 090       | 0.01028         | 6.63            | 30                                            |
| 0.1019   | 2.588  | 10 380       | 0.008155        | 5.26            | 25                                            |
| 0.0907   | 2.304  | 8 230        | 0.00646         | 4.17            | 25                                            |
| 0.0808   | 2.052  | 6 530        | 0.00513         | 3.31            | 25                                            |
| 0.0720   | 1.829  | 5 180        | 0.00407         | 2.63            | 25                                            |
| 0.0641   | 1.628  | 4 110        | 0.00323         | 2.08            | 25                                            |
| 0.0571   | 1.450  | 3 260        | 0.00256         | 1.65            | 25                                            |
| 0.0508   | 1.290  | 2 580        | 0.00203         | 1.31            | 25                                            |
| 0.0453   | 1.151  | 2 050        | 0.00161         | 1.04            | 25                                            |
| 0.0403   | 1.024  | 1 620        | 0.00128         | 0.823           | 25                                            |
| 0.0359   | 0.912  | 1 290        | 0.00101         | 0.654           | 25                                            |
| 0.0320   | 0.813  | 1 020        | 0.000804        | 0.517           | 25                                            |
| 0.0285   | 0.724  | 812          | 0.000638        | 0.411           | 25                                            |
| 0.0253   | 0.643  | 640          | 0.000503        | 0.324           | 25                                            |
| 0.0226   | 0.574  | 511          | 0.000401        | 0.259           | 25                                            |
| 0.0201   | 0.511  | 404          | 0.000317        | 0.205           | 20                                            |
| 0.0179   | 0.455  | 320          | 0.000252        | 0.162           | 20                                            |
| 0.0159   | 0.404  | 253          | 0.000199        | 0.128           | 20                                            |
| 0.0142   | 0.361  | 202          | 0.000158        | 0.102           | 20                                            |
| 0.0126   | 0.320  | 159          | 0.000125        | 0.081           | 20                                            |
| 0.0113   | 0.287  | 128          | 0.000100        | 0.065           | 20                                            |
| 0.0100   | 0.254  | 100          | 0.0000785       | 0.051           | 15                                            |
| 0.0089   | 0.226  | 79.2         | 0.0000622       | 0.040           | 15                                            |
| 0.0080   | 0.203  | 64.0         | 0.0000503       | 0.032           | 15                                            |
| 0.0071   | 0.180  | 50.4         | 0.0000396       | 0.026           | 15                                            |
| 0.0063   | 0.160  | 39.7         | 0.0000312       | 0.020           | 15                                            |
| 0.0056   | 0.142  | 31.4         | 0.0000246       | 0.016           | 15                                            |
| 0.0050   | 0.127  | 25.0         | 0.0000196       | 0.013           | 15                                            |
| 0.0045   | 0.114  | 20.2         | 0.000 0159      | 0.010           | 15                                            |
| 0.0040   | 0.102  | 16.0         | 0.0000126       | 0.0081          | 15                                            |
| 0.0035   | 0.089  | 12.2         | 0.00000962      | 0.0062          | 15                                            |
| 0.0031   | 0.079  | 9.61         | 0.00000755      | 0.0049          | 15                                            |

measured between gage marks placed originally 10 in. (254 mm) apart upon the test specimen (Explanatory Note 4). The elongation of wire whose nominal diameter is 0.0808 in. and under may be determined as described above or by measurements made between the jaws of the testing machine. When the latter method is used, the zero length shall be the distance between the jaws at the start of the tension test and be as near 10 in. as practicable, and the final length shall be the distance between the jaws at the time of rupture. The fracture shall be between gage marks in the case of specimens so marked or between the jaws of the testing machine and not closer than 1 in. (25.4 mm) to either gage mark or either jaw.

6.2 *Resistivity*—Determine the electrical resistivity of the material in accordance with Test Method B 193 (Explanatory Note 5). The purchaser may accept certification that the wire was drawn from stock meeting the international standard for annealed copper instead of resistivity tests on the finished wire.

6.3 *Dimensional Measurements*—Make dimensional measurements with a micrometer caliper equipped with a

vernier graduated in 0.0001 in. (0.0025 mm). Take measurements on at least three places on each unit selected for this test. If accessible, take one measurement on each end and one near the middle. The average of the three measurements shall determine compliance with the requirements.

6.4 *Surface Finish*—Make a surface-finish inspection with the unaided eye (normal spectacles excepted).

## 7. Conformance Criteria (Explanatory Note 6)

7.1 Any lot of wire, the samples of which comply with the conformance criteria of this section, shall be considered as complying with the requirements of Section 5. Individual production units that fail to meet one or more of the requirements shall be rejected. Failure of a sample group from a lot to meet one or more of the following criteria shall constitute cause for rejection of the lot. The conformance criteria for each of the prescribed properties given in Section 5 are as follows:

7.1.1 *Elongation*—The lot shall be considered conforming if the average elongation of the four specimens is not less than the appropriate elongation value in Table 1 plus 2.5

**TABLE 2 Sampling for Dimensional Measurements**

| Number of Units in Lot | First Sample                     |                                                    | Second Sample                    |                  |                                                    |
|------------------------|----------------------------------|----------------------------------------------------|----------------------------------|------------------|----------------------------------------------------|
|                        | Number of Units in Sample, $n_1$ | Allowable Number of Defects in First Sample, $c_1$ | Number of Units in Sample, $n_2$ | $n_1$ plus $n_2$ | Allowable Number of Defects in Both Samples, $c_2$ |
| 1 to 30, incl          | all                              | 0                                                  | ...                              | ...              | ...                                                |
| 15 to 50, incl         | 14                               | 0                                                  | ...                              | ...              | ...                                                |
| 51 to 100, incl        | 19                               | 0                                                  | 23                               | 42               | 1                                                  |
| 101 to 200, incl       | 24                               | 0                                                  | 46                               | 70               | 2                                                  |
| 201 to 400, incl       | 29                               | 0                                                  | 76                               | 105              | 3                                                  |
| 401 to 800, incl       | 33                               | 0                                                  | 112                              | 145              | 4                                                  |
| Over 800               | 34                               | 0                                                  | 116                              | 150              | 4                                                  |

percentage points; however any individual production unit, the specimen from which has an elongation less than the appropriate elongation value in Table 1, shall be rejected.

7.1.1.1 The lot shall be considered to have failed to meet the elongation conformance criterion if the average of the four specimens is less than the elongation in Table 1 plus 2.5 percentage points *and* elongation of any of the individual specimens is less than the value in Table 1.

7.1.1.2 If the average of the four specimens is less than the elongation in Table 1 plus 2.5 percentage points and the elongation of each of the individual specimens is equal to or more than the value in Table 1, six additional specimens from six production units, other than the four originally sampled shall be tested. The lot shall be considered conforming if the elongation of each of the ten specimens is not less than the appropriate elongation value in Table 1, and the average of the ten specimens is not less than that value plus 2.5 percentage points. The lot shall be considered to have failed to meet the elongation requirement if any of the ten specimens is less than the appropriate elongation value in Table 1 or if the average of the ten specimens is less than that value plus 2.5 percentage points.

7.1.2 *Resistivity*—The electrical resistivity of each of the four specimens shall conform to the requirements of 5.3. Failure to meet these requirements shall constitute failure to meet the resistivity conformance criterion.

7.1.3 *Dimensions*—The dimensions of the first sample (Table 2) shall conform to the requirements of 5.4. If there are no failures, the lot conforms to this requirement. If there are failures but the number of these does not exceed the allowable defect number,  $c_2$  (Table 2), for the respective number of units in the sample, a second sample equal to  $n_2$  shall be taken and the total defects of the  $n_1$  plus  $n_2$  units shall not exceed the allowable defect number,  $c_2$ . Failure to meet this requirement shall constitute failure to meet the dimensional conformational criterion.

7.1.4 *Surface Finish*—The surface finish of the samples taken in accordance with Table 3 shall conform to the requirements of 5.5. The number of units in the sample showing surface defects not consistent with commercial practice shall not exceed the allowable defect number,  $c$ , in Table 3. Failure to meet this requirement shall constitute failure to meet the surface-finish conformance criterion.

7.1.5 *Packaging*—Conformance to the packaging requirements specified by the purchaser shall be determined in accordance with Table 3. The number of units in the sample showing nonconformance to the requirement shall not exceed the allowable defect number,  $c$ , in Table 3. Failure to meet this requirement shall constitute failure to meet the

**TABLE 3 Sampling for Surface Finish and Packaging Inspection**

| Number of Units in Lot | Number of Units in Sample, $n$ | Allowable Number of Defective Units, $c$ |
|------------------------|--------------------------------|------------------------------------------|
| 1 to 30, incl          | all                            | 0                                        |
| 31 to 50, incl         | 30                             | 0                                        |
| 51 to 100, incl        | 37                             | 0                                        |
| 101 to 200, incl       | 40                             | 0                                        |
| 201 to 300, incl       | 70                             | 1                                        |
| 301 to 500, incl       | 100                            | 2                                        |
| 501 to 800, incl       | 130                            | 3                                        |
| Over 800               | 155                            | 4                                        |

packaging conformance criterion.

## 8. Density

8.1 For the purpose of calculating mass per unit length, cross-sections, etc., the density of the copper shall be taken as 8.89 g/cm<sup>3</sup> (0.32117 lb/in.<sup>3</sup>) at 20°C (Explanatory Note 7).

## 9. Inspection

9.1 *General* (Explanatory Note 6)—All tests and inspections shall be made at the place of manufacture unless agreed upon between the manufacturer and the purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification.

9.1.1 Unless otherwise agreed upon between the purchaser and the manufacturer, conformance of the wire to the various requirements listed in Section 5 shall be determined on samples taken from each lot of wire presented for acceptance.

9.1.2 The manufacturer shall, if requested prior to inspection, certify that all wire in the lot was made under such conditions that the product as a whole conforms to the requirements of this specification as determined by regularly made and recorded tests.

### 9.2 Inspection and Testing Terms:

9.2.1 *Lot*—A lot is any amount of wire of one type and size presented for acceptance at one time, such amount, however, not to exceed 100 000 lb (45 000 kg) (Explanatory Note 8).

9.2.2 *Sample*—A sample is a quantity of production units (coils, reels, etc.) selected at random from the lot for the purpose of determining conformance of the lot to the requirements of this specification.

9.2.3 *Specimen*—A specimen is a length of wire removed

for test purposes from any individual production unit of the sample.

9.3 *Sample Size*—The number of production units in a sample (Explanatory Note 6) shall be as follows:

9.3.1 For elongation and resistivity determinations, the sample shall consist of four production units. From each unit, one test specimen of sufficient length shall be removed for the performance of the required tests.

9.3.2 For dimensional measurements, the sample shall consist of a quantity of production units shown in Table 2 under the heading "First Sample."

9.3.3 For surface-finish inspection and for packaging inspection (when specified by the purchaser at the time of

placing the order) the sample shall consist of a quantity of production units shown in Table 3.

## 10. Packaging and Package Marking

10.1 Package sizes shall be agreed upon between the manufacturer and the purchaser in the placing of individual orders.

10.2 The wire shall be protected against damage in ordinary handling and shipping.

## 11. Keywords

11.1 copper electrical conductor; copper wire; electrical conductor; electrical conductor—copper; soft or annealed copper wire

## EXPLANATORY NOTES

NOTE 1—Soft or annealed copper wire is wire which has been drawn to size by customary operations and then annealed. When necessary it is finished by cleaning to remove scale or oxide. The wire is soft and ductile, easily marred, and even stretched by careless handling. It is therefore necessary that the requirements of this specification relating to elongation properties and resistivity refer to the wire as it is put up by the manufacturer, and before being put through processes incident to its use by the purchaser.

NOTE 2—Other tests than those provided in this specification have been considered at various times, such as twist tests, wrap tests, tests for elastic limit, etc. It is the opinion of the committee that twist and wrap tests on soft wire do not serve a useful purpose and should be regarded as undesirable, as well as inconclusive as to results and significance. Tests for values of elastic limit are likewise indefinite as to results.

NOTE 3—The values of the wire diameters in Table 1 are given to the nearest 0.0001 in. (0.001 mm) and correspond to the standard sizes given in Specification B 258. The use of gage numbers to specify wire sizes is not recognized in this specification because of the possibility of confusion. An excellent discussion of wire gages and related subjects is contained in *NIST Handbook 100*.

NOTE 4—In general, tested values of tensile strength are increased and tested values of elongation are reduced with increase of speed of the moving head of the testing machine in the tension testing of copper wire. In the case of tests on soft or annealed copper wire, however, the effects of speed of testing are not pronounced. Tests of soft wire made at speeds of moving head which under no-load conditions are not greater than 12 in. (305 mm)/min do not alter the final results of tensile strength and elongation determinations to any practical extent.

NOTE 5—"Resistivity" is used in place of "percentage conductivity." The value of 0.15328  $\Omega \cdot \text{g}/\text{m}^2$  at 20°C is the international standard for the resistivity of annealed copper equal to 100 % conductivity. This term means that a wire 1 m in length and weighing 1 g would have a

resistance of 0.15328  $\Omega$ . This is equivalent to a resistivity value of 875.20  $\Omega \cdot \text{lb}/\text{mile}^2$  which signifies the resistance of a wire 1 mile in length weighing 1 lb. It is also equivalent, for example, to 1.7241  $\mu\Omega/\text{cm}$  of length of a bar 1  $\text{cm}^2$  in cross-section. A complete discussion of this subject is contained in *NBS Handbook 100*. Relationships which may be useful in connection with the value of resistivity prescribed in this specification are shown in Table 4.

NOTE 6—Cumulative results secured on the product of a single manufacturer, indicating continued conformance to the criteria, are necessary to ensure an over-all product meeting the requirements of this specification. The sample sizes and conformance criteria given for the various characteristics are applicable only to lots produced under these conditions.

NOTE 7—The value of density of copper is in accordance with the International Annealed Copper Standard. The corresponding value at 0°C is 8.90  $\text{g}/\text{cm}^3$  (0.32150  $\text{lb}/\text{in}^3$ ).

NOTE 8—A lot should comprise material taken from a product regularly meeting the requirements of this specification. Inspection of individual lots of less than 5000 lb (2270 kg) of wire cannot be justified economically. For small lots of 5000 lb or less the purchaser may agree to the manufacturer's regular inspection of the product as a whole as evidence of acceptability of such small lots.

TABLE 4 Resistivity Relationships

| Conductivity at<br>(20°C), %           | 100.00   |
|----------------------------------------|----------|
| $\Omega \cdot \text{lb}/\text{mile}^2$ | 875.20   |
| $\Omega \cdot \text{g}/\text{m}^2$     | 0.15328  |
| $\Omega \cdot \text{cmil}/\text{ft}$   | 10.371   |
| $\Omega \cdot \text{mm}^2/\text{m}$    | 0.017241 |
| $\mu\Omega \cdot \text{in.}$           | 0.67879  |
| $\mu\Omega \cdot \text{cm}$            | 1.7241   |

## SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, or order, for agencies of the U. S. Government.

### S1. Referenced Documents

S1.1 The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

### S1.2 Military Specifications<sup>5</sup>

MIL-C-12000 Cable, Cord, and Wire, Electric; Packaging of

<sup>5</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.



## S2. Inspection

S2.1 The government shall have the right to perform any of the inspections and tests set forth in this specification when such tests are deemed necessary to ensure that the

material conforms to the prescribed requirements.

## S3. Packaging

S3.1 Packaging shall be in accordance with MIL-C-12000.

*The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.*

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BARE COPPER WIRE ----- SOFT

| AWG | NOM.  | MIN.  | MAX.  | ELONG. | BREAKING STRENGTH |              |              | RES. - 1000 FT. |              |       | TENSILE<br>P.S.I.<br>MAX. |
|-----|-------|-------|-------|--------|-------------------|--------------|--------------|-----------------|--------------|-------|---------------------------|
|     |       |       |       |        | SOFT<br>MAX.      | MED.<br>HARD | HARD<br>MIN. | HARD            | MED.<br>HARD | SOFT  |                           |
| 40  | .0031 | .0030 | .0032 | 15     | .3106             | .4685        | .5592        | 1091            | 1085         | 1069  | 40000                     |
| 39  | .0035 | .0034 | .0036 | 15     | .3917             | .5876        | .7031        | 865.0           | 860.5        | 847.4 | 40000                     |
| 38  | .0040 | .0039 | .0041 | 15     | .4939             | .7367        | .8829        | 686.0           | 682.4        | 672.0 | 40000                     |
| 37  | .0044 | .0043 | .0045 | 15     | .6228             | .9238        | 1.110        | 544.0           | 541.2        | 532.9 | 40000                     |
| 36  | .0050 | .0049 | .0051 | 15     | .7854             | 1.158        | 1.396        | 431.4           | 429.2        | 422.6 | 40000                     |
| 35  | .0056 | .0055 | .0057 | 15     | .9908             | 1.452        | 1.755        | 342.1           | 340.4        | 335.2 | 40000                     |
| 34  | .0063 | .0062 | .0064 | 15     | 1.249             | 1.821        | 2.204        | 271.3           | 269.9        | 265.8 | 40000                     |
| 33  | .0071 | .0070 | .0072 | 15     | 1.575             | 2.283        | 2.772        | 215.2           | 214.1        | 210.8 | 40000                     |
| 32  | .0080 | .0079 | .0081 | 15     | 1.986             | 2.862        | 3.458        | 170.6           | 169.8        | 167.2 | 40000                     |
| 31  | .0089 | .0088 | .0090 | 15     | 2.504             | 3.589        | 4.376        | 135.3           | 134.6        | 132.6 | 40000                     |
| 30  | .0100 | .0099 | .0101 | 15     | 3.157             | 4.499        | 5.502        | 107.3           | 106.8        | 105.1 | 40000                     |
| 29  | .0113 | .0112 | .0114 | 20     | 3.981             | 5.640        | 6.918        | 85.10           | 84.66        | 83.37 | 40000                     |
| 28  | .0126 | .0125 | .0127 | 20     | 5.021             | 7.070        | 8.698        | 67.49           | 67.14        | 66.11 | 40000                     |
| 27  | .0142 | .0141 | .0143 | 20     | 6.331             | 8.863        | 10.92        | 53.52           | 53.25        | 52.43 | 40000                     |
| 26  | .0159 | .0157 | .0161 | 20     | 7.983             | 11.11        | 13.73        | 42.44           | 42.23        | 41.58 | 40000                     |
| 25  | .0179 | .0177 | .0181 | 20     | 10.07             | 13.92        | 17.26        | 33.66           | 33.49        | 32.97 | 40000                     |
| 24  | .0201 | .0199 | .0203 | 20     | 12.69             | 17.45        | 21.67        | 26.69           | 26.56        | 26.15 | 40000                     |
| 23  | .0226 | .0224 | .0228 | 25     | 15.41             | 21.87        | 27.25        | 21.17           | 21.06        | 20.74 | 38500                     |
| 22  | .0253 | .0250 | .0256 | 25     | 19.43             | 27.41        | 34.26        | 16.79           | 16.70        | 16.46 | 38500                     |
| 21  | .0285 | .0282 | .0288 | 25     | 24.50             | 34.36        | 43.07        | 13.31           | 13.24        | 13.04 | 38500                     |
| 20  | .0320 | .0317 | .0323 | 25     | 30.89             | 43.05        | 54.08        | 10.56           | 10.50        | 10.34 | 38500                     |
| 19  | .0359 | .0355 | .0363 | 25     | 38.95             | 53.95        | 67.99        | 8.373           | 8.330        | 8.202 | 38500                     |
| 18  | .0403 | .0399 | .0407 | 25     | 49.12             | 67.61        | 85.47        | 6.640           | 6.606        | 6.505 | 38500                     |
| 17  | .0453 | .0448 | .0458 | 25     | 61.93             | 84.71        | 107.5        | 5.266           | 5.239        | 5.158 | 38500                     |
| 16  | .0508 | .0503 | .0513 | 25     | 78.10             | 106.2        | 135.1        | 4.176           | 4.154        | 4.091 | 38500                     |
| 15  | .0571 | .0565 | .0577 | 25     | 98.48             | 133.0        | 169.8        | 3.312           | 3.295        | 3.244 | 38500                     |
| 14  | .0641 | .0635 | .0647 | 25     | 124.2             | 166.6        | 213.5        | 2.626           | 2.613        | 2.573 | 38500                     |
| 13  | .0720 | .0713 | .0727 | 25     | 156.6             | 208.8        | 268.0        | 2.083           | 2.072        | 2.040 | 38500                     |
| 12  | .0808 | .0800 | .0816 | 25     | 197.5             | 261.6        | 337.0        | 1.652           | 1.643        | 1.618 | 38500                     |
| 11  | .0907 | .0898 | .0916 | 25     | 249.0             | 327.6        | 422.9        | 1.310           | 1.303        | 1.283 | 38500                     |
| 10  | .1019 | .1009 | .1029 | 25     | 314.0             | 410.4        | 529.2        | 1.039           | 1.033        | 1.018 | 38500                     |
| 9   | .1144 | .1133 | .1155 | 30     | 380.5             | 514.2        | 661.2        | .8238           | .8195        | .8070 | 37000                     |
| 8   | .1285 | .1272 | .1297 | 30     | 479.8             | 643.9        | 826.0        | .6533           | .6499        | .6400 | 37000                     |
| 7   | .1443 | .1429 | .1457 | 30     | 605.0             | 806.6        | 1030         | .5181           | .5154        | .5075 | 37000                     |
| 6   | .1620 | .1604 | .1636 | 30     | 762.9             | 1010         | 1280         | .4108           | .4087        | .4025 | 37000                     |
| 5   | .1819 | .1801 | .1837 | 30     | 961.9             | 1264         | 1591         | .3258           | .3241        | .3192 | 37000                     |
| 4   | .2043 | .2023 | .2063 | 30     | 1213              | 1584         | 1970         | .2584           | .2570        | .2531 | 37000                     |
| 3   | .2294 | .2271 | .2317 | 30     | 1530              | 1984         | 2439         | .2049           | .2038        | .2007 | 37000                     |
| 2   | .2576 | .2550 | .2602 | 30     | 1929              | 2450         | 3003         | .1625           | .1617        | .1592 | 37000                     |
| 1   | .2893 | .2864 | .2922 | 30     | 2432              | 3024         | 3688         | .1287           | .1282        | .1262 | 37000                     |

PATRICK,

THIS IS THE CHART THAT WE DISCUSSED

LEWIS,  
Don Phelps C.W. Co.