



Standard Specification for Tungsten Plate, Sheet, and Foil¹

This standard is issued under the fixed designation B760; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers wrought unalloyed tungsten plate, sheet, and foil.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The following precautionary caveat pertains only to the test method portions 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 *ASTM Standards*:²

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

3. Terminology

3.1 *Lot Definitions*:

3.1.1 *ingot, n*—no definition required.

3.1.2 A manufacturing lot shall consist of a material of the same size, shape, condition, and finish produced from the ingot or powder blend by the same rolling reduction schedule and the same heat treatment parameters. Unless otherwise agreed between manufacturer and purchaser, a lot shall be limited to the product of an 8 h period for final continuous anneal, or to a single furnace load for final batch anneal.

3.1.3 A chemical analysis lot shall consist of a single powder blend in the case of products manufactured from

pressed and sintered powder metallurgy shapes, or a single ingot in the case of products manufactured from ingot.

3.2 *Product Forms*:

3.2.1 *foil, n*—a flat product less than 0.005 in. (0.13 mm) in thickness.

3.2.2 *plate, n*—a flat product 0.188 in. (4.75 mm) or more in thickness.

3.2.3 *sheet, n*—a flat product from .005 in. (0.13 mm) to 0.187 in. (4.75 mm) in thickness.

4. Ordering Information

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

4.1.1 Material identification and metallurgical condition (Section 7),

4.1.2 Product form (Section 3),

4.1.3 Chemical requirements (Table 1),

4.1.4 Tolerances (Section 9, Table 2, and Fig. 1),

4.1.5 Workmanship and quality level requirements (Section 10),

4.1.6 Packaging (Section 14),

4.1.7 Marking (Section 14),

4.1.8 Certification and reports (Section 13), and

4.1.9 Disposition of rejected material (Section 12).

5. Materials and Manufacture

5.1 The various tungsten flat products covered by this specification shall be formed with the conventional rolling, forging, or extrusion equipment, normally found in primary ferrous and nonferrous plants.

5.2 The ingot metal is consolidated employing either the powder metallurgy or vacuum-arc-casting process.

6. Chemical Composition

6.1 The tungsten ingots or billets for conversion to finished products covered by this specification shall conform to the requirements of the chemical composition prescribed in Table 1.

6.2 *Heat Analysis*:

6.2.1 Heat analysis is an analysis made by the manufacturer of the metal on a representative sample of powder from a single powder blend in the case of material made from pressed and

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

TABLE 1 Chemical Composition/Check Analysis

| Element | Composition, max, % | Permissible Variations in Check Analysis, % |
|----------------|---------------------|---|
| C | 0.010 | ±0.002 |
| O ^A | 0.010 | + 10 % relative |
| N | 0.010 | + 0.0005 |
| Fe | 0.010 | + 0.001 |
| Ni | 0.010 | + 0.001 |
| Si | 0.010 | + 0.001 |

^A If chemical analysis is performed on a sample from the powder blend used to make the finished product, oxygen will be reported for information only.

sintered powder billets, or on a representative sample of a cast ingot or intermediate product from that ingot in the case of material made from cast ingot.

6.2.2 Chemical lot analysis shall be as specified in **Table 1**, with the exception of oxygen which shall be reported for information only, and not be required to meet the requirements of **Table 1**.

6.3 Check Analysis:

6.3.1 Check analysis is an analysis made by the purchaser or the manufacturer of the metal after it has been processed into finished mill forms, and is either for the purpose of verifying the composition of a heat or lot, or to determine variations in the composition within a heat or lot.

6.3.2 Check analysis tolerances do not broaden the specified heat analysis requirements but cover variations between laboratories in the measurement of chemical content.

6.3.3 Check analysis limits shall be as specified in **Table 1**.

6.3.4 The manufacturer shall not ship material that is outside the limits specified in **Table 1**.

7. Metallurgical Condition

7.1 Plate, sheet and foil shall be furnished in one of the following conditions as designated on the purchase order:

| Form | Metallurgical Condition |
|-------|------------------------------|
| Plate | hot-rolled |
| Sheet | hot-rolled, stress-relieved |
| | hot-rolled, stress-relieved |
| Foil | hot-rolled, stress-relieved |
| | cold-rolled |
| | cold-rolled, stress-relieved |

7.2 Other conditions can be specified as agreed upon between the purchaser and the manufacturer at the time of purchase.

8. Significance of Numerical Limits

8.1 For the purpose of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value or a calculated value shall be rounded as indicated in accordance with the rounding methods of Practice **E29**.

| Property | Rounded Unit for Observed or Calculated Value |
|---|---|
| Chemical composition, and tolerances (when expressed as decimals) | nearest unit in the last right-hand place of figures of the specified limit |
| Tensile strength and yield strength | nearest 1000 psi (10 MPa) |
| Elongation | nearest 1 % |

9. Permissible Variations in Dimensions

9.1 The thickness tolerances on tungsten products covered by this specification shall be as specified in **Table 2**.

9.2 The width tolerances shall be as agreed upon between the manufacturer and the purchaser. In general, shearing tolerance will be ± 1/16 in. (± 1.6 mm) and slitting tolerance will be ± 1/32 in. (± 0.8 mm).

9.3 The length and camber tolerances shall be as agreed upon between the manufacturer and the purchaser. In general, length and camber tolerances will show a maximum deviation of + 1/16 in., - 0/ft (1.6 mm/m) of length.

9.4 Flatness tolerances on tungsten flat products shall be as follows:

| Thickness, in.(mm) | Flatness Deviation, max, % |
|-------------------------|----------------------------|
| 0.005–0.187 (0.13–4.75) | 4 |
| 0.188–0.625 (4.75–15.9) | 5 |

9.4.1 Determine flatness deviation (**Fig. 1**) as follows:

$$\text{Flatness deviation, \%} = (H/L) \times 100$$

where:

- H = maximum vertical distance between a flat reference surface and the lower surface of the flat product, and
- L = minimum horizontal distance between the highest point of the flat product where H is determined, and the point of contact of the lower surface of the flat product with a flat reference surface.

10. Workmanship, Finish, and Appearance

10.1 Cracks, seams, slivers, blisters, burrs, and other injurious imperfections shall not exceed standards of acceptability agreed upon by the manufacturer and the purchaser.

10.2 Tungsten plate, sheet, and foil shall be free of injurious internal and external imperfections of a nature that will interfere with the purpose for which it was intended.

10.3 Methods of testing for these defects and standards of acceptability shall be as agreed upon between the manufacturer and the purchaser.

10.4 Material may be supplied with as-rolled, as-cleaned, as-machined, or as-ground finish.

10.5 The manufacturer shall be permitted to remove surface imperfections provided such removal does not reduce the dimensions below the minimum permitted by the tolerances for that dimension.

11. Sampling and Test Methods

11.1 Care shall be exercised to ensure that the sample selected for testing is representative of the material and form and that it is not contaminated by the sampling procedure. If there is any question relating to the sampling technique or the analysis of the sample, the methods of sampling and analysis shall be as agreed upon between the purchaser and the manufacturer.

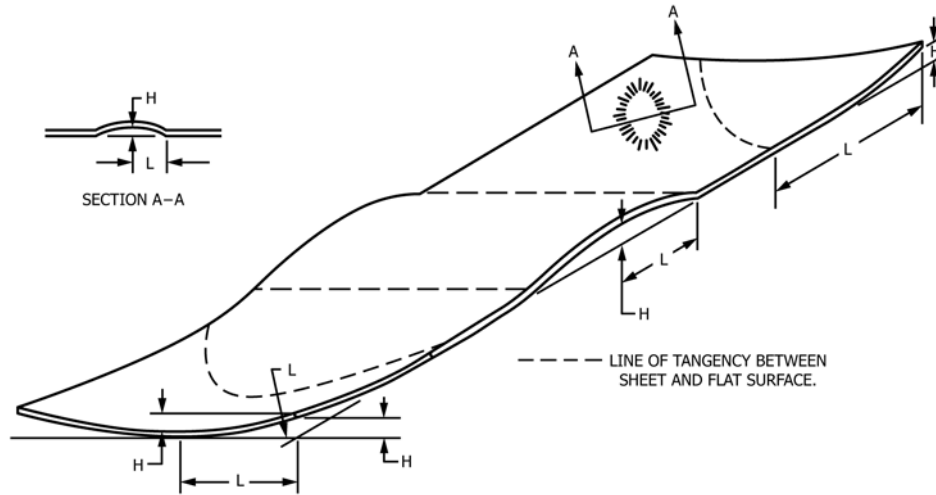
11.2 Test Methods:

11.2.1 Chemistry:

TABLE 2 Permissible Thickness Variations

| Specified Width, in. (mm) | Specified Thickness, in. (mm) | Thickness Tolerance, ^A in. (mm) |
|------------------------------|----------------------------------|---|
| 12 (305) and under | 0.005 to 0.010 (0.13–0.25) | ±0.001 (±0.0254) |
| | over 0.010 to 0.020 (0.25–0.51) | ±0.002 (±0.051) |
| | over 0.020 (0.51) | ±10 % |
| Over 12 to 24 (305–610), | over 0.010 to 0.025 (0.25–0.64) | ±0.0025 (±0.064) |
| | over 0.025 (0.64) | ±10 % |

^A Tolerances for foil shall be as agreed upon between the producer and the purchaser.



Flatness Deviation, % = (H/L) x 100

H = maximum distance between flat surface and lower surface of sheet.
L = minimum distance between highest point on sheet and point of contact with flat surface.

FIG. 1 Plate and Sheet Flatness Tolerances

11.2.1.1 Analyses shall be made using the manufacturer’s standard methods.

11.2.1.2 The chemical composition enumerated in this specification shall in case of disagreement, be determined in accordance with the methods approved for referee purposes by ASTM International. Where such methods are not available, methods of analysis as mutually agreed upon by the manufacturer and the purchaser shall be employed.

12. Rejection and Referee

12.1 Material that fails to conform to the requirements of this specification or to authorized modifications may be rejected. Rejection for failure of the material to meet the requirements of this specification shall be reported to the manufacturer within 30 calendar days from the receipt of the material by the purchaser.

12.2 Unless otherwise specified, rejected material may be returned to the manufacturer at the manufacturer’s expense, unless the purchaser receives, within four weeks of the notice of rejection, other instructions for disposition.

12.3 In the event of disagreement between the manufacturer and the purchaser on the conformance of the material to the requirements of the specification or any special test specified by the purchaser, a mutually acceptable referee shall perform

the tests in question. The results of the referee’s testing shall be used in determining conformance of the material to this specification.

13. Certification

13.1 If requested, the manufacturer shall supply at least three copies of a report of the heat analysis of each melt or powder lot represented in the shipment, and reports of the result of tests of each size of each heat or powder lot to determine properties.

13.2 The report shall include the purchase order number, heat or powder lot number, this specification number, type and metallurgical condition, nominal thickness, and quantity and number of items covered by the shipment.

14. Packaging and Package Marking

14.1 *Identification*—Unless otherwise specified, each plate or sheet shall be legibly and conspicuously marked or tagged with the number of this specification, material type and metallurgical condition, heat or lot number, manufacturer’s identification, and the nominal thickness gage in inches. All markings must withstand ordinary handling and shall be capable of removal with standard cleaning solvents. The marking shall have no deleterious effect on the material or its performance.

14.1.1 Coiled sheet and foil shall be similarly marked at the outside end of each coil.

14.2 All material shall be packaged in such a manner as to assure safe delivery to its destination when properly transported by any common carrier.

14.3 The package shall be so marked as to indicate the nature of any special handling required.

14.4 Each bundle, box, or coil shall be legibly and conspicuously marked or tagged with the following information:

14.4.1 Purchase order or contract number,

14.4.2 Name of material,

14.4.3 Grade,

14.4.4 Size,

14.4.5 Lot, heat, or ingot number,

14.4.6 Metallurgical condition,

14.4.7 Gross, net and tare weights, and

14.4.8 ASTM specification number.

15. Keywords

15.1 foil; plate; sheet; tungsten

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