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SPECIFICATIONS AND TOLERANCES FOR REFERENCE STANDARDS AND FIELD STANDARD WEIGHTS AND MEASURES

1. SPECIFICATIONS AND TOLERANCES FOR FIELD STANDARD WEIGHTS



UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
HANDBOOK 105-1

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Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures

1. Specifications and Tolerances for Field Standard Weights (NBS Class F)

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U. S. National Bureau of Standards Handbook 105-1

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Abstract

These specifications and tolerances are intended to set forth minimum requirements for standards used in the field by State and local weights and measures officials in the official examination of weighing and measuring devices used in commerce. They should be considered also as appropriate for device installers and repairmen.

Although the National Bureau of Standards has no regulatory authority in this area, its organic legislation (31 Stat. 1449) specifically authorizes "The custody, maintenance, and development of the national standards of measurement, and the provision of means and methods for making measurements consistent with those standards . . . and cooperation with the States in securing uniformity in weights and measures laws and methods of inspection."

Key Words: Cooperation for uniformity of measurements; field standard weights; specifications; tolerances; weights and measures inspection.

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Foreword

These specifications and tolerances are intended to set forth minimum requirements for standards used: 1) In the field by State and local weights and measures officials in the official examination of weighing and measuring devices used in commerce; 2) by device installers and repairmen; 3) as reference standards in State weights and measures laboratories; and 4) in industrial and educational and research laboratories.

Although the National Bureau of Standards has no regulatory authority in this area, its organic legislation (31 Stat. 1449) specifically authorizes

“the custody, maintenance, and development of the national standards of measurement, and the provision of means and methods for making measurements consistent with those standards” and “cooperation with the States in securing uniformity in weights and measures laws and methods of inspection.”

The materials, design, fabrication, and error limitation of field standards are such as to permit the use of the standards in normal testing operations at nominal values. Reference standards are of such design, material, and accuracy that, even though used regularly in the laboratory, they will remain stable with little or no change in standard values.

Field standards are relatable to the U.S. Prototype standards for length, mass, and capacity through comparison with State reference standards, which themselves are compared with national standards at the National Bureau of Standards. In normal use field standards should be calibrated annually. Damage or unusually hard use will make necessary more frequent calibration; less than normal use may permit less frequent calibration, although calibration less than biennially should definitely be avoided.

A. V. ASTIN, *Director*,
National Bureau of Standards.

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1. Specifications and Tolerances for Field Standard Weights (NBS Class F)

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General

A field standard weight (Class F) is intended to be used primarily by the weights and measures officials in the testing of commercial weighing devices.¹

Specifications

1. Material

1.1. A field standard of 0.01 pound or 5 grams (up to and including 10 pounds or 5 kilograms), shall be constructed of hard material, such as stainless steel, and be resistant to abrasion, corrosion, denting, and chipping.

1.2. A field standard smaller than 0.01 pound or 5 grams may be sheet metal and may be constructed of stainless steel, tantalum, nickel-chromium alloy, or aluminum alloy, and sufficiently resistant to corrosion and oxidation that the surface need not be protected or coated.

1.3. A field standard larger than 10 pounds or 5 kilograms shall be constructed of materials such as steel or stainless steel, having a hardness of Vickers 220 or greater, and be resistant to abrasion, denting, and chipping. Cast iron may be used for weights larger than 20 pounds.

2. Finish

2.1. The surface of a field standard weight shall be smooth, free from scratches, dents, and chipped corners or edges.

2.2. No surface coating of any kind shall be used on a field weight up to and including 10 pounds or 5 kilograms.

2.3. A field standard weight larger than 10 pounds or 5 kilograms constructed of materials susceptible to corrosion or tarnishing shall be protected by a suitable surface cover such as plating, painting or lacquering. If paint or lacquer is used, it shall be hard and not likely to chip.

3. Density

3.1. The density of a field standard weight, except weights smaller than 0.01 pound or 5 grams, shall be not less than 7.0 and not more than 9.0 g/cm³.

3.2. The density of a field standard weight smaller than 0.01 pound or 5 grams may be 2.6 g/cm³ or more.

4. Design

4.1. No special form is required. Manufacturers are urged to submit proposed designs to the Office of Weights and Measures, National Bureau of Standards, Washington, D.C. 20234, for consideration before fabrication is begun. See figures 1 to 5.

4.2. A field standard weight shall be so designed that no part of it can be removed or replaced without defacing the weight or destroying a seal. A field standard weight having a removable knob, handle, rest pad, or other similar part is included in this class only if such part is secured in a manner as to prevent its removal without defacing the weight or destroying a seal.

4.3. To reduce the likelihood of chipping of corners and edges, all corners and edges shall be rounded with a well-defined radius. Sharp edges and corners will not be acceptable. Except for a

¹NBS Handbook 44, Specifications, Tolerances, and other Technical Requirements for Commercial Weighing and Measuring Devices.

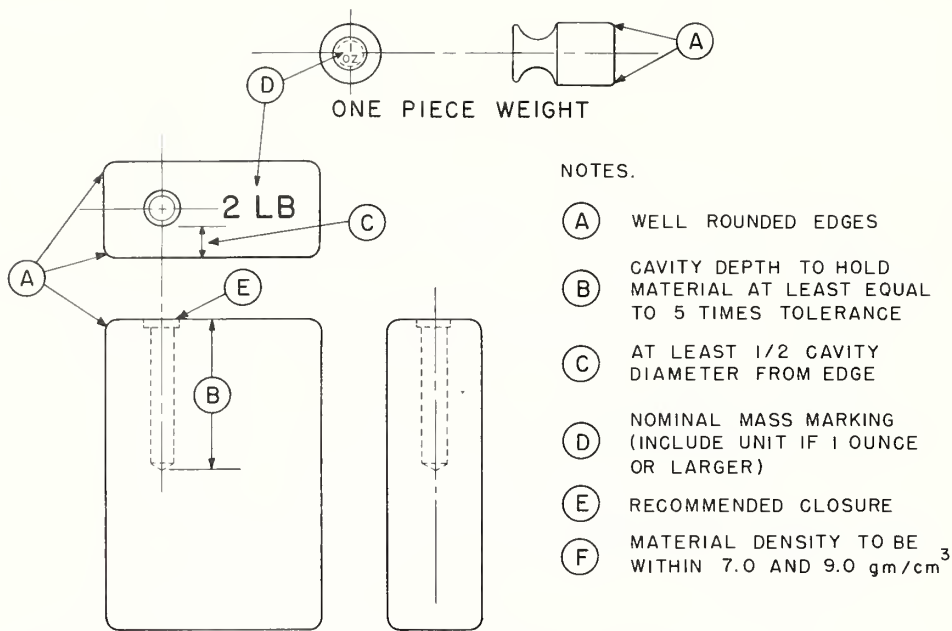


FIGURE 1. Small field standard weights.

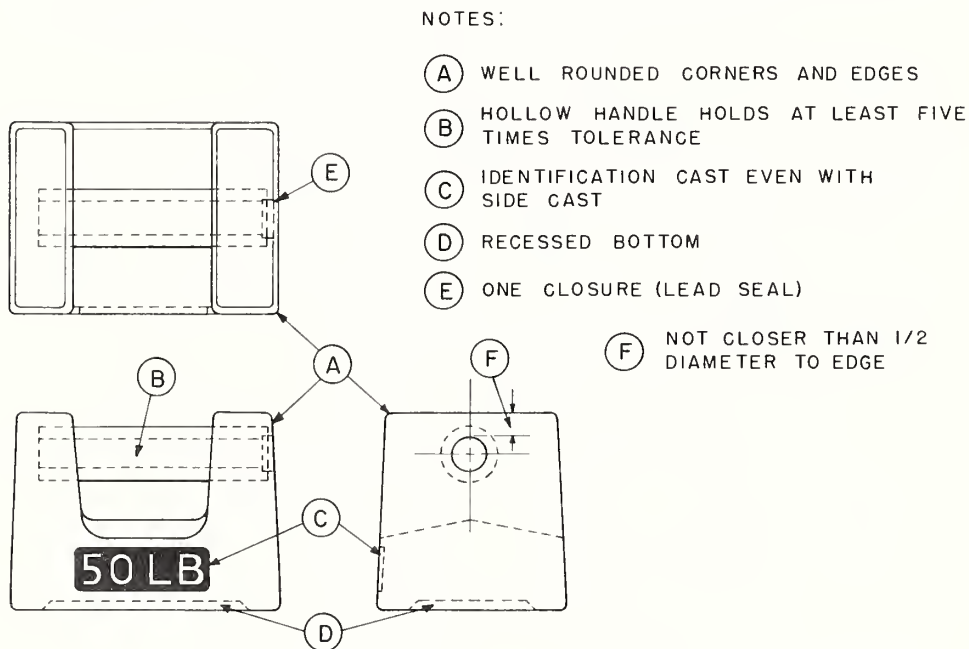


FIGURE 2. Large field standard weight.

"cube" weight, the bottom surface of a field standard weight larger than 0.0625 pound (1 ounce) or 30 grams, shall be recessed.

5. Adjusting Cavity

5.1. A field standard weight 0.1250 pound (2 ounces) or 50 grams and larger may have an adjusting cavity.

5.2. A weight smaller than 0.1250 pound (2 ounces) or 50 grams shall be of one-piece construction.

5.3. A field standard weight having an adjusting cavity shall have a single cavity which opens on the top or side surface of the weight.

5.4. There shall be not more than one opening to an adjusting cavity.

NOTES:

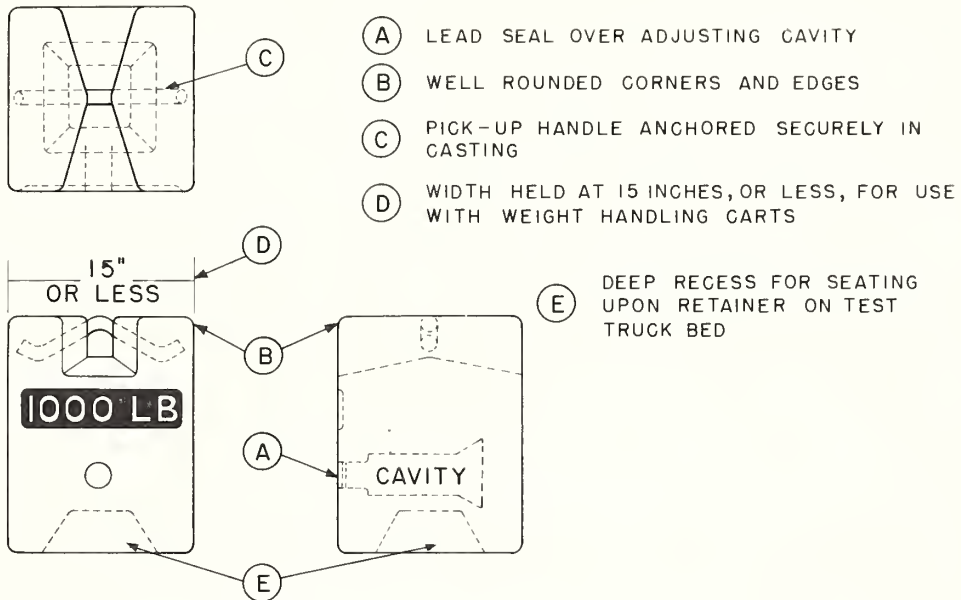


FIGURE 3. Large field standard weight.

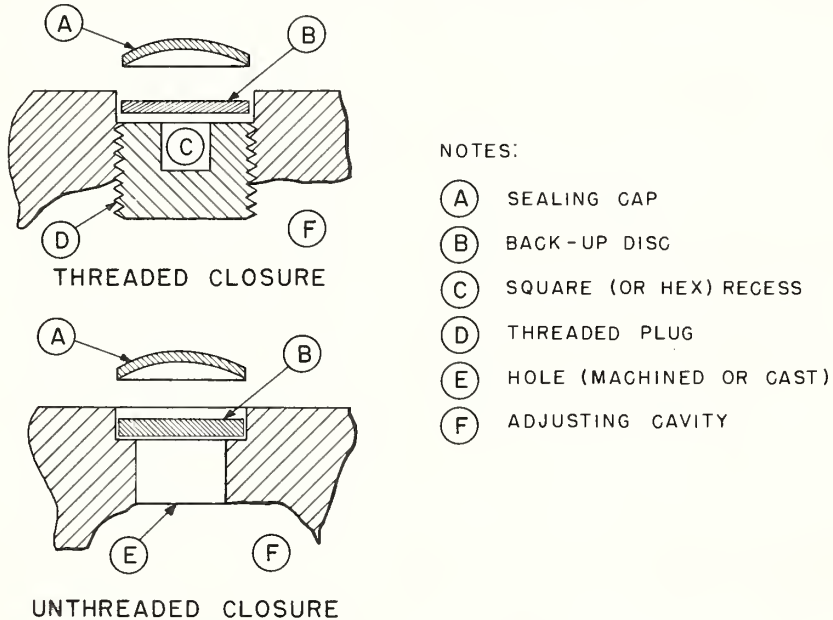


FIGURE 4. Adjusting cavity closure (field standard weight).

5.5. The cavity opening shall be not closer to the edge of the weight than one-half of the diameter of the opening.

5.6. The cavity shall be large enough to contain adjusting material equal to five times the applicable tolerance.

6. Adjusting Cavity Closure

6.1. For a weight having an adjusting cavity (other than the cavity under a pinned screw knob),

the cavity opening shall be machined (counter-bored) for a backup disk, or tapped to accommodate a threaded plug. When an appropriate sealing cap is applied, the seal shall be even with, or slightly below, the surface of the weight.

6.2. The sealing cap shall be of soft, noncorrosive material so that it easily can be removed for readjustment of the weight. Lead sealing caps are recommended for a field standard weight larger

NOTES:

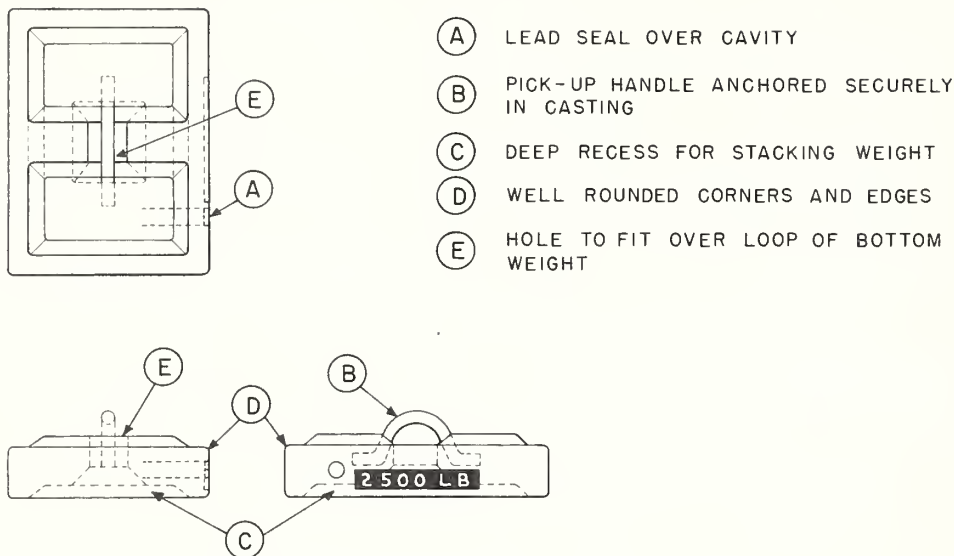


FIGURE 5. Large field standard weight (nesting weight).

than 10 pounds or 5 kilograms. Aluminum is recommended for a smaller weight.

7. Adjusting Material

7.1. Adjusting material should be a metallic material similar to that of the field standard weight. Lead may be used in a cast iron weight 25 pounds and larger.

8. Identification

8.1. A weight shall be clearly marked with its nominal mass value.

8.2. A weight shall be marked with the unit name and a number representing the nominal mass, except cylinder weights smaller than 0.0625 pound (1 ounce) or 30 grams, and sheet metal weights smaller than 0.001 pound or 500 milligrams. (See tables 1 and 2 for accepted unit abbreviations.)

8.3. Identification shall be located on the upper or side surface of a weight. The markings shall be shallow, relatively broad, and free from burrs and sharp angles or edges. They shall not perforate or crack a sheet metal weight, or cause any raised area on the bottom surface of the weight; except in the case of a sheet metal weight, no numeral or letter shall be raised above the surface.

8.4. Identification cast in a cast iron weight shall be located on the side of the weight only and shall be even with, or slightly below, the surface of the weight. In no instance shall numerals or letters be raised above the surface of the weight.

8.5. No other markings shall be used on field standard weights 10 pounds or 5 kilograms and smaller.

8.6. Markings such as trade marks or name of the maker on a field standard weight are considered unnecessary and, if used, shall be limited to the shortest name or initials by which the firm is commonly known. Letters in the identification marking shall be no larger than those of the denomination. Manufacturers are urged to refrain from using unnecessary markings.

9. Carrying Case

9.1. Field standard weights up to and including 10 pounds or 5 kilograms shall be carried in a rigid, covered case designed to keep the weights in their pockets. Each weight shall have a separate pocket lined with a nonabrasive and noncorrosive material.

Tolerances

1. Adjustment

1.1. A weight of this class shall be maintained so that the difference between the actual value and the nominal value does not exceed the prescribed plus or minus tolerances of tables 1, 2, 3, and 4.

1.2. A new weight or newly adjusted weight shall be adjusted as near to the nominal value as practicable, but in no case shall the actual value differ from the nominal value by more than one-half the applicable tolerance.

TABLE 1.—CLASS F TOLERANCES FOR FIELD STANDARD WEIGHTS (AVOIRDUPOIS)

For weight denominations smaller than 0.1 pound, intermediate between those listed below, the tolerance for the lower denomination shall be applied.

| Denomination | Tolerances |
|--------------------|---------------------------|
| <i>Pounds (lb)</i> | <i>Pounds (lb)</i> |
| 10, 000 | 1. 00 |
| 5, 000 | . 50 |
| 3, 000 | . 30 |
| 2, 500 | . 25 |
| 2, 000 | . 20 |
| 1, 000 | . 10 |
| 500 | . 05 |
| 100 | . 010 |
| 50 | . 005 |
| 30 | . 003 |
| 20 | . 002 |
| 10 | . 001 |
| | <i>Micropounds (μlb)*</i> |
| 5 | 500 |
| 3 | 300 |
| 2 | 200 |
| 1 | 100 |
| 0. 5 | 50 |
| 0. 3 | 30 |
| 0. 2 | 20 |
| 0. 1 | 15 |
| 0. 05 | 10 |
| 0. 03 | 7 |
| 0. 02 | 5 |
| 0. 01 | 3 |
| 0. 005 | 2 |
| 0. 003 | 2 |
| 0. 002 | 2 |
| 0. 001 | 2 |

For weight denominations intermediate between those listed below, the tolerance value for the lower denomination shall be applied.

| Denomination | Tolerances |
|--------------------|---------------------------|
| <i>Ounces (oz)</i> | <i>Micropounds (μlb)*</i> |
| 8 | 50 |
| 4 | 25 |
| 2 | 12 |
| 1 | 7 |
| ½ | 5 |
| ¼ | 3 |
| ⅛ | 2 |
| ⅙ | 2 |
| 0. 5 | 5 |
| 0. 3 | 3 |
| 0. 2 | 2 |
| 0. 1 | 2 |
| 0. 05 | 2 |
| 0. 03 | 2 |
| 0. 02 | 2 |
| 0. 01 | 2 |

*1 μlb=0.000001 lb.

TABLE 2.—CLASS F TOLERANCES FOR FIELD STANDARD WEIGHTS (APOTHECARY)

For weight denominations intermediate between those listed below, the tolerance value for the lower denomination shall be applied.

| Denomination | Tolerances |
|-----------------------------------|---|
| <i>Ounces Apothecary (oz ap)</i> | <i>Micropounds (μlb)* (avoirdupois)</i> |
| 12 | 100 |
| 10 | 80 |
| 6 | 50 |
| 5 | 40 |
| 4 | 35 |
| 3 | 25 |
| 2 | 20 |
| 1 | 10 |
| <i>Dram, Apothecary (dr ap)</i> | |
| 6 | 8 |
| 5 | 6 |
| 4 | 5 |
| 3 | 4 |
| 2 | 4 |
| 1 | 3 |
| <i>Scruple, Apothecary (s ap)</i> | |
| 2 | 3 |
| 1 | 2 |

*1 μlb=0.000001 lb (avoirdupois).

TABLE 3.—CLASS F TOLERANCES FOR FIELD STANDARD WEIGHTS (GRAINS)

For weight denominations intermediate between those listed below, the tolerance value for the lower denomination shall be applied.

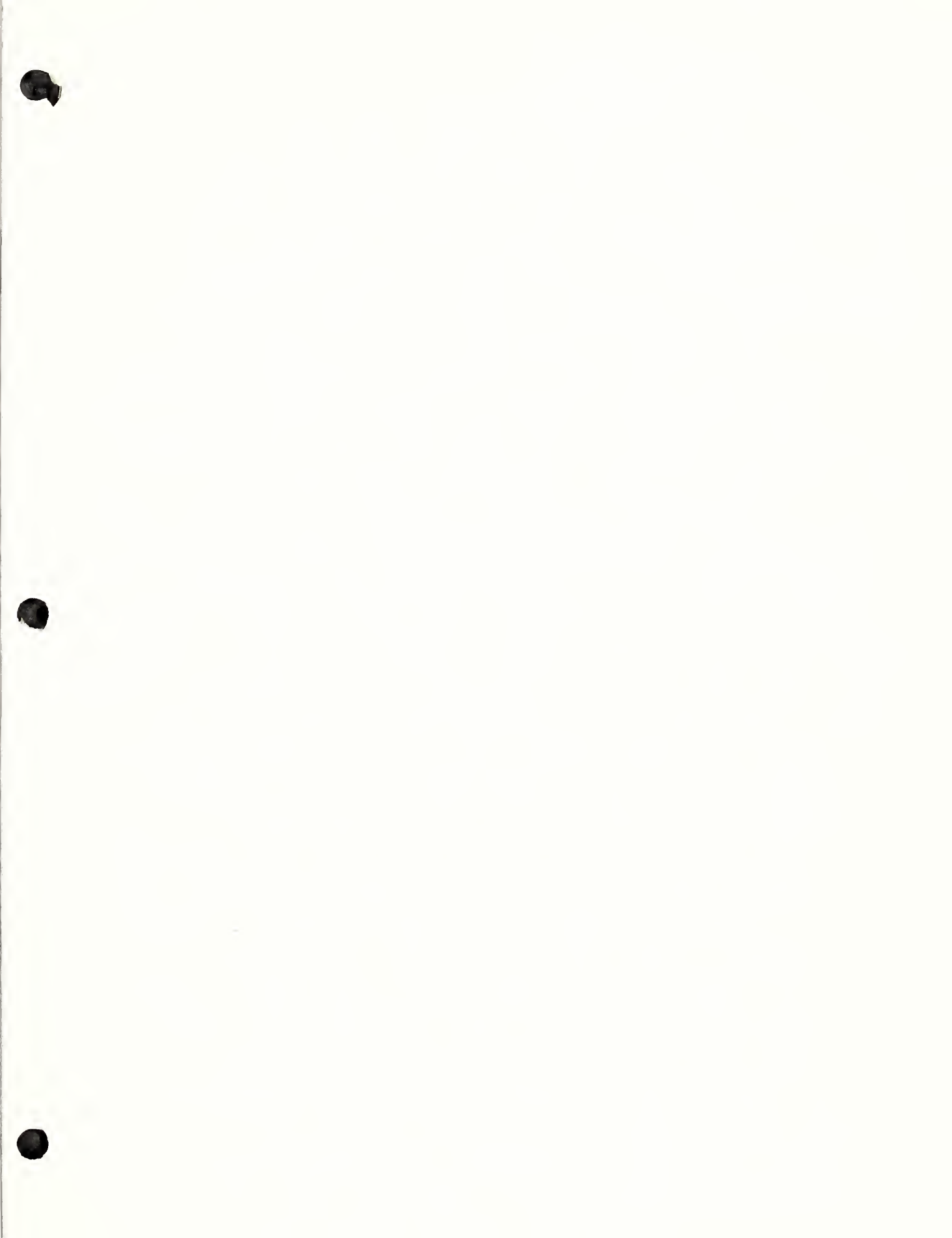
| Denomination | Tolerances |
|-----------------------|----------------------------|
| <i>Grains (grain)</i> | <i>Micropounds (μ lb)*</i> |
| 10, 000 | 140 |
| 5, 000 | 70 |
| 3, 000 | 45 |
| 2, 000 | 30 |
| 1, 000 | 14 |
| 500 | 7 |
| 300 | 5 |
| 200 | 3 |
| 100 | 2 |
| 50 | 2 |
| 30 | 2 |
| 20 | 2 |
| 10 | 2 |
| 5 | 1 |
| 3 | 1 |
| 2 | 1 |
| 1 | 1 |
| 0. 5 | 1 |

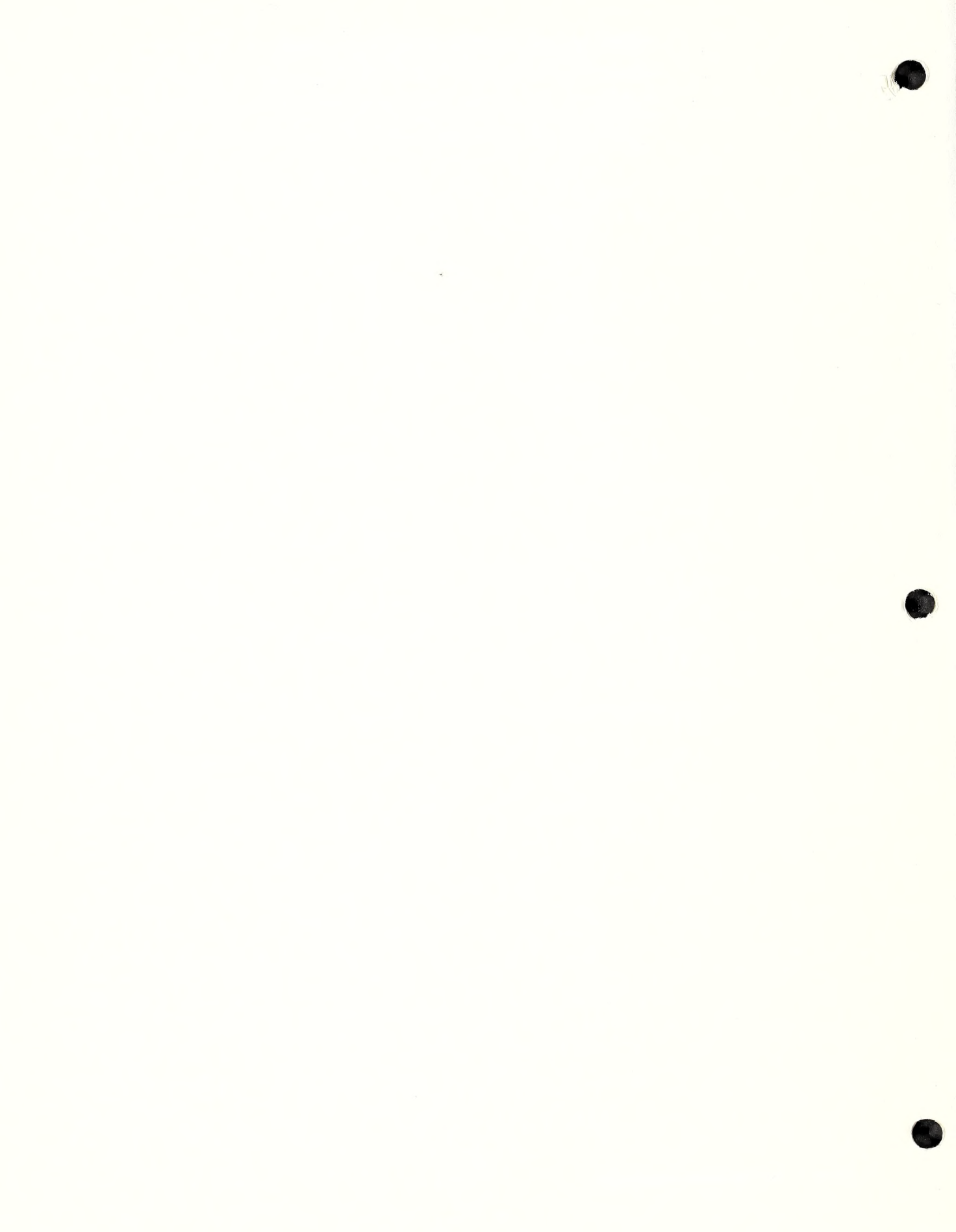
*1 μ lb=0.000001 lb.

TABLE 4.—CLASS F TOLERANCES FOR FIELD
STANDARD WEIGHTS (METRIC)

For weight denominations smaller than 100 grams, intermediate between those listed below, the tolerance value for the lower denomination shall be applied.

| Denomination | Tolerances |
|------------------------|------------------------|
| <i>Kilograms (kg)</i> | <i>Grams (g)</i> |
| 500 | 50.0 |
| 300 | 30.0 |
| 200 | 20.0 |
| 100 | 10.0 |
| 50 | 5.00 |
| 30 | 3.00 |
| 20 | 2.00 |
| 10 | 1.00 |
| | <i>Milligrams (mg)</i> |
| 5 | 500 |
| 3 | 300 |
| 2 | 200 |
| 1 | 100 |
| <i>Grams (g)</i> | |
| 500 | 50 |
| 300 | 30 |
| 200 | 20 |
| 100 | 10 |
| 50 | 7 |
| 30 | 5 |
| 20 | 3 |
| 10 | 2 |
| 5 | 2 |
| 3 | 2 |
| 2 | 2 |
| 1 | 2 |
| <i>Milligrams (mg)</i> | |
| 500 | 1 |
| 300 | 1 |
| 200 | 1 |
| 100 | 1 |





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