Designation: D 648 – 07

Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position[1]

This standard is issued under the fixed designation D 648; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers the determination of the temperature at which arbitrary deformations occur when specimens are subjected to predetermined conditions of loaded outer-fiber stress, environment, and rate of heating.

1.2 This test method is applicable to bars molded directly from plastic molding and extrusion materials and to bars cut from sheets, plates, and large castings. Unless otherwise specified, the standard bar shall be 5 in. [127 mm] long, 0.5 in. [12.7 mm] wide, and 0.25 in. [6.4 mm] thick. When specified, bars 0.125 in. [3.2 mm] thick or 0.040 in. [1.0 mm] thick may be tested. Bars 0.25 in. thick are preferred. The actual dimensions of the test bars shall be recorded. The thickness and width shall be measured to the nearest 0.001 in. [0.02 mm] for bars 0.25 in. thick and to the nearest 0.0005 in. [0.01 mm] for bars 0.125 in. thick or 0.040 in. thick.

1.3 This test method is designed mainly for materials that have a deflection temperature under load between room temperature and 600°F [316°C]. This test method may be used for materials with higher deflection temperatures.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses (or in SI units) are for information only.

1.5 *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.*

1.6 This test method is technically equivalent to Method B of this test method, Method A and Method B of ISO 75-1 and ISO 75-2, 1993, and may be considered equivalent for practical purposes.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 618 Practice for Conditioning Plastics for Testing

D 883 Terminology Relating to Plastics

D 1898 Practice for Sampling of Plastics[3]

D 5947 Test Methods for Physical Dimensions of Solid Plastics Specimens

D 1 Specification for Apparatus for Determination of Deflection Temperature of Plastics

D 77 Test Method for Deflection Temperature of Plastics Under Flexural Load

D 608/D 608M Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

D 691 Specification for Mineral Oil for Use in Deflection Temperature Tests

D 1137/D 1137M Test Methods for Deflection Temperature of Plastics Under Flexural Load in Water

2.2 *ISO Standards:*[4]

ISO 75-1 Plastics—Determination of Temperature of Deflection under Load—Part 1: General Test Method

ISO 75-2 Plastics—Determination of Temperature of Deflection under Load—Part 2: Plastics and Ebonite

2.3 *NIST Document:*[5]

NBS Special Publication 250-22

3. Terminology

3.1 *General*—The definitions of terms relating to this test method appear in Terminology D 883, unless otherwise defined.

4. Summary of Test Method

4.1 A bar is forced edgewise as a simple beam in the three-point configuration and subjected to a constant outer-fiber stress of 0.455 MPa [66 psi], 1.82 MPa [264 psi] (Note 3). The temperature is raised at 2 ± 0.2°C/min. The deflection is measured and recorded when the bar has deflected 0.25 mm [0.010 in.]. This temperature is reported as the deflection temperature under the given conditions of fiber stress and rate of heating.

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.30 on Thermal Properties (Section D20.30.02).

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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.

[3] Withdrawn.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[5] Heat, B. et al., "Thermal Analysis Applied to Irradiated Propellants," *NBS Special Publication 250-22*, 1987. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

***A Summary of Changes section appears at the end of this standard.**

NOTE 3—[illegible]

5. Significance and Use

5.1 [illegible]

6. Interferences

6.1 [illegible]

6.2 [illegible]

6.3 [illegible]

6.4 [illegible] (either 100 [illegible] 101.6 [illegible]) [illegible]

7. Apparatus

7.1 [illegible] Fig. 1 [illegible]:

7.1.1 *Specimen Supports*, [illegible] 7.1.1.1 [illegible] 7.1.1.2. [illegible] of 3 ± 0.2 [illegible] [0.118 ± 0.008 in.].

7.1.1.1 [illegible] A—101.6 ± 0.5 [illegible] [4.0 ± 0.02 in.].

7.1.1.2 [illegible] B—100.0 ± 0.5 [illegible] [3.937 ± 0.020 in.].

7.1.2 *Immersion Bath*—[illegible] 4) [illegible] of 2 ± 0.2 [illegible]/[illegible]. [illegible]

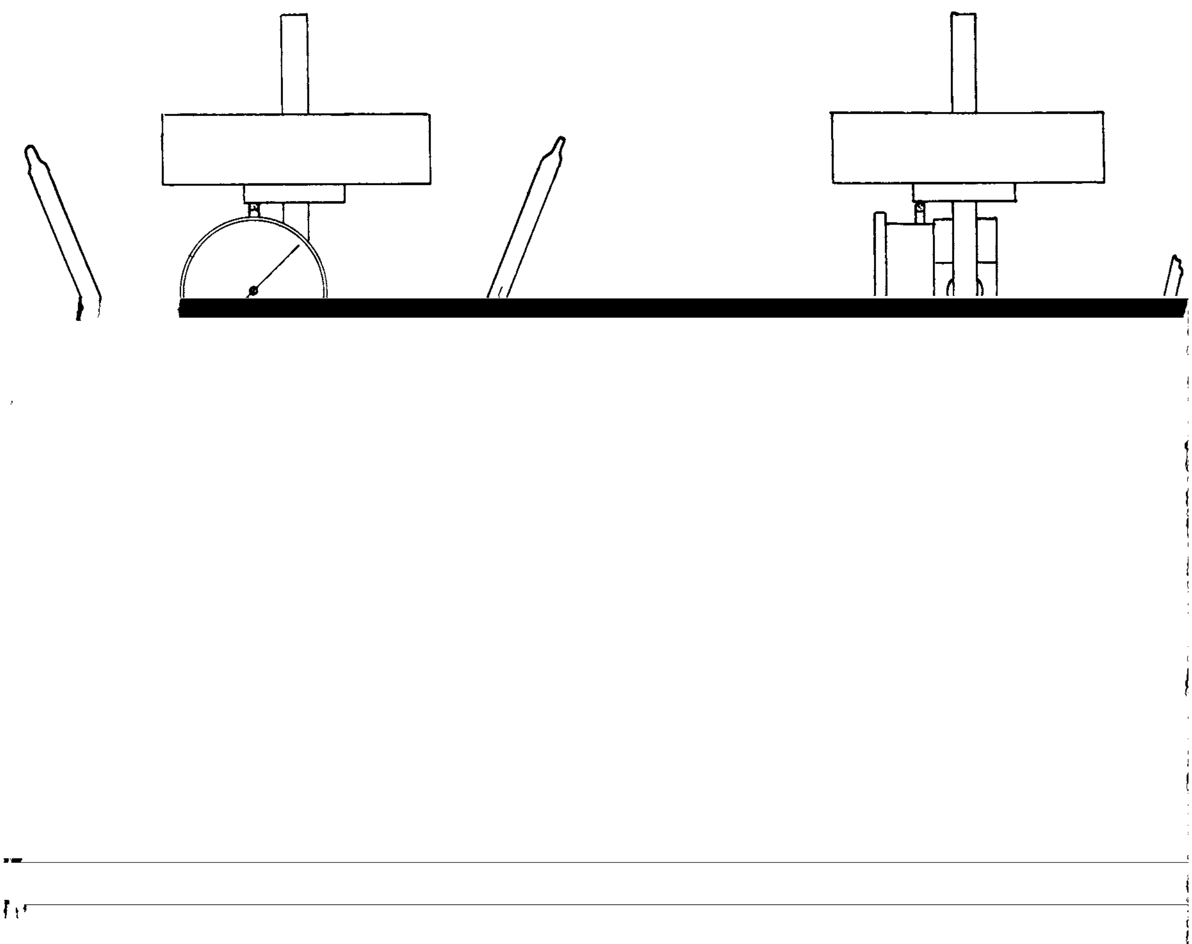

FIG. 1 Apparatus for Deflection Temperature Test

5- [illegible] 10 ± 1 [illegible]

4 A [illegible] 115 [illegible] 260 [illegible]

5 A [illegible]

7.1.3 *Deflection Measurement Device*, [illegible] 0.25 [0.010 [illegible]]. [illegible] 0.01 [0.0005 [illegible]]. This [illegible] ± 2.5 % [illegible] 1.82 [illegible] [264 [illegible]]. ± 2.5 %. This [illegible] 7.1.1.1 [illegible] 7.1.1.2.

7.1.4 *Weights* [illegible] 0.455 [illegible] [66 [illegible]] ± 2.5 % [illegible] 1.82 [illegible] [264 [illegible]]. ± 2.5 %. This [illegible] 7).

$$F = 2Sbd^2/3L \quad (1)$$

$$F^1 = F/9.80665$$

$$m_w = (F \quad F_s)/9.80665 \quad m_r$$

[illegible]:

F = [illegible],
F^1 = [illegible], kgf,
S = [illegible] (0.455 [illegible] 1.82 [illegible]),
b = [illegible],
d = [illegible],
L = [illegible], (101.6 [illegible] A, 100 [illegible] B), [illegible] 7.1.1.1 [illegible] 7.1.1.2.
m_w = [illegible], kg,
F_s = [illegible], [illegible] (7.1.4), [illegible], kg, and
m_r = [illegible], kg.

6 [illegible] A [illegible] 1 [illegible] A [illegible] 2 [illegible] A [illegible] 3 [illegible]

7.1.5 *Temperature Measurement System*

7.1.5.1 *Digital Indicating System* [illegible] ±0.5 [illegible] 608/ 608 [illegible] 1137/ 1137 [illegible].

7.1.5.2 *Thermometer* [illegible] 1: This [illegible] 2, [illegible] 20 [illegible] 150 [illegible] 5 [illegible] 300 [illegible] 77.

7.2 *Micrometers* [illegible] 5947 [illegible]

8. Sampling

8.1 [illegible] 1898. [illegible]

9. Test Specimen

9.1 [illegible] 127 [illegible] [5 [illegible]] [illegible] 13 [illegible] [$\frac{1}{2}$ [illegible]] [illegible] 3 [illegible] [$\frac{1}{8}$ [illegible]]; 13 [illegible] [$\frac{1}{2}$ [illegible]]. [illegible] ±0.13 [illegible] [0.005 [illegible]] [illegible].

7 This [illegible] 13 [illegible] 2 4 [illegible] 4 [illegible]

9.2 This [illegible]

9.3 [illegible]

10. Preparation of Apparatus

10.1 This [illegible] 7.1.3. This [illegible]

[illegible] 76 [illegible] [3 in.] [illegible] 7.1.5.

NOTE 8—[illegible]

11. Conditioning

11.1 *Conditioning*—[illegible] 23 ± 2 [illegible] [73.4 ± 3.6 [illegible]] and 50 ± 5 % [illegible] 40 h [illegible] D618 [illegible] ±1 [illegible] [1.8 [illegible]] and ±2 % [illegible].

NOTE 9—[illegible]

12. Procedure

12.1 [illegible] 7.2 [illegible]

TABLE 1 Statistical Information[A]

Polymer	Average[B] Value	Standard Deviation	Critical[C] Difference, Within Laboratories	Critical Difference, Between Laboratories
Polyethylene, 0.455 MPa	85.3	4.8	6.0	9.4
Polycarbonate, 0.455 MPa	142.0	2.0	2.3	3.9
Methyl methacrylate, 1.82 MPa	97.6	2.9	4.0	5.7
Polysulfone, 1.82 MPa	173.8	2.8	2.3	5.5

[A] All values are given in °C.
[B] Average of pairs.
[C] Between values of a pair.

TABLE 2 Precision, Deflection Temperature

Units Expressed in °C			
Material	Average	S_r[A]	S_R

14.2 In 1995 a round robin[7] was conducted. Table 2 is based on this round robin and is in accordance with D 691, using 15 laboratories. For each material, all of the test specimens were prepared

[7] Supporting data are available from ASTM Headquarters. Request RR: D20-1202.

from the same lot. Each laboratory obtained and tested five specimens. (**Warning**—The following explanations of *r* and *R* (14.3-14.3.3) are only intended to present a meaningful way of considering the approximate precision of this test method. The data in Table 2 should not be rigorously applied to acceptance or rejection of materials, as those data are specific only to the round robin described and may not be representative of other lots, conditions, materials, or laboratories. Users of this test method should apply the principles outlined in Practice D 691 to generate data specific to their materials and laboratories (or between specific laboratories). The principles of 14.3-14.3.3 would then be valid for such data.)

14.3 *Concept of r and R in Table 2* If S_r and S_R have been calculated from a large enough body of data, and for test results that were averages from testing of five specimens for each test result, then:

14.3.1 *Repeatability*, *r*, is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory. Two test results shall be judged not equivalent if they differ by more than the *r* value for that material.

14.3.2 *Reproducibility*, *R*, is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories. Two test results shall be judged not equivalent if they differ by more than the *R* value for that material.

14.3.3 Any judgment in accordance with 14.3.1 or 14.3.2 would have an approximate 95 % (0.95) probability of being correct.

14.4 The precision data were determined in accordance with this test method.

15 Based on the round robin,[7] the precision of this test method is estimated to be 101.6 °F [4.0 °F.] (Test Method A) and 100 °F [3.937 °F.] (Test Method B), for materials having deflection temperatures under 1.0-4.5 MPa. For materials having deflection temperatures over 100 °F, and for different materials, laboratories, or specimen preparation, the precision may be substantially different (see Table 3).

15. Keywords

15.1 deflection temperature; heat distortion; plastics

ANNEXES

(Mandatory Information)

A1. CALIBRATION OF SINGLE-(CENTRALIZED) TEMPERATURE PROBE UNITS

A1.1 [illegible]

A1.2 [illegible]

A1.3 [illegible] T, [illegible] 0.1 [illegible]

A1.3.1 [illegible] T [illegible] 10 [illegible] 20 [illegible] 50 [illegible] 0.1 [illegible] ±0.1 [illegible]

A1.3.1.1 [illegible] T [illegible] 10 [illegible]

A1.3.2 [illegible]

A2. CALIBRATION OF MULTI-TEMPERATURE INSTRUMENTS

A2.1 [illegible] Annex A1.

A2.2 [illegible]

A2.3 A [illegible] 0.1 [illegible] 0.001 [illegible] 0.1 [illegible]

A2.4 [illegible]

A2.4.1 [illegible]

A2.4.2 [illegible]

A2.4.3 [illegible]

A2.4.4 [illegible] ( ) [illegible] T) [illegible] ( ) [illegible] ≤10 [illegible]

A2.4.5 [illegible] T [illegible] ±0.1 [illegible] ( ) [illegible] ( ).

A2.5 [illegible] T [illegible] 2 [illegible] (120 [illegible]/h). [illegible] high [illegible] T [illegible]

[illegible]

A2.5.1 [illegible] 7.1.2. [illegible]

A2.6 A [illegible] T [illegible] 20 [illegible] 0.013 [illegible] [0.0005 in.], [illegible]

APPENDIXES

(Nonmandatory Information)

X1. PROCEDURE FOR DETERMINATION OF CORRECT SPECIMEN LOADING UTILIZING EQUILIBRIUM WEIGHING OF THE LOADING ROD

X1.1 Apparatus

X1.1.1 The apparatus shall consist of the following (see Fig. X1.1 and Fig. X1.2):

X1.1.1.1 *Single-Pan or Equal-Arm Laboratory Balance*, having a capacity of 1 kg or more and a sensitivity of 0.1 g.

X1.1.1.2 *Platform Assembly*, for supporting the loading rod in the horizontal position.

X1.1.1.3 *Bridge Platform*, for placing the loading rod on the platform assembly.

X1.2 Procedure

X1.2.1 Place the loading rod, clean and free of grease, on the platform assembly as shown in Fig. X1.1.

X1.2.2 Place the balancing weight on the other pan of the balance (hanger, if necessary, for attaching balancing weight).

X1.2.3 Balance the assembly.

X1.2.4 Place the specimen, with the specimen and loading rod centered as shown in Fig. X1.2, on the platform assembly.

X1.2.5 Determine the mass of the specimen.

X1.2.6 Place the specimen on the loading rod at the position of the specimen axis.

X1.2.7 Calculate the mass of the balancing weight required to balance the specimen.

X1.2.8 If the balancing weight is placed on the pan on the specimen side of the balance, the mass of the balancing weight (specimen side) shall be 13 [12 lb.] plus the mass of the specimen.

X1.2.9 Adjust the mass of the balancing weight (other side) to balance the assembly.

X1.2.10 With the specimen and loading rod in position, the balancing weight, specimen side, and the balancing weight, other side, in place, the balance in equilibrium, the mass of the balancing weight, specimen side, shall be 0.89 ± 0.05 [0.035 ± 0.002 lb.] (0.64 [0.025 lb.] as the mass of the loading rod and 0.25 [0.010 lb.] for the mass of the specimen). Adjust the balancing weight, other side, to 0.89 ± 0.05 [0.035 ± 0.002 lb.].

X1.2.11 Remove the specimen, leaving the 0.89 ± 0.05-[0.035 ± 0.002-lb.] balancing weight in place.

X1.2.12 Adjust the balancing weight, specimen side, to balance the assembly. The mass of the balancing weight is 0.89-[0.035-lb.] less than required in X1.2.8.

X2.2 Procedure

2.2.1 [illegible]

2.2.2 [illegible]

2.2.3 [illegible] 12.7 [illegible]

2.2.4 [illegible]

2.2.5 [illegible]

2.2.6 [illegible] 0.51 [0.02 in.]/[illegible]. [illegible]

2.2.7 [illegible] 0.89 ± 0.05-[illegible] [0.035 ± 0.002-in.] [illegible]

2.2.8 [illegible] 1.

X3. PROCEDURE FOR DETERMINATION OF CORRECT SPECIMEN LOADING BY WEIGHING THE APPLIED LOAD IN SITU

X3.1 Scope

3.1.1 [illegible]

3.1.2 [illegible]

3.1.3 [illegible]

X3.2 Apparatus

3.2.1 [illegible] Fig. 3.1 [illegible]

3.2.1.1 *Electronic Weighing System with Load Cell* [illegible], [illegible] 2000 g [illegible] 0.1 g.

3.2.1.2 *Platform Assembly*, [illegible]

3.2.1.3 *Mass Support Unit*, [illegible]

3.2.1.4 *Adjustment Fitting*, [illegible]

X3.3 Procedure

3.3.1 [illegible] 1.

3.3.2 [illegible]

3.3.3 [illegible]

[illegible] g [illegible] g.

4.3 Th[illegible]

4.4 [illegible] f [illegible] g[illegible] A[illegible] f [illegible] 1.00-[illegible]. If [illegible] 1.00-[illegible] 1.016-[illegible] [0.040-in.] g[illegible].

4.5 [illegible]. A[illegible] [illegible].

[illegible].

NOTE 4.1 [illegible].

4.6 If [illegible] 1.00-[illegible] 1.00 ± 0.02 [illegible].

4.7 [illegible].

4.8 [illegible].

X5. PROCEDURE FOR DETERMINATION OF SPRING FORCE AND CONDITION OF GAUGE

X5.1 Apparatus

5.1.1 Th[illegible] Fig. 5.1 [illegible]:

5.1.1.1 *Testing Machine* A [illegible].

5.1.1.2 *Load Measurement Device* Th[illegible] 0.5 g.

5.1.1.3 *Event Detector (Optional)* Th[illegible].

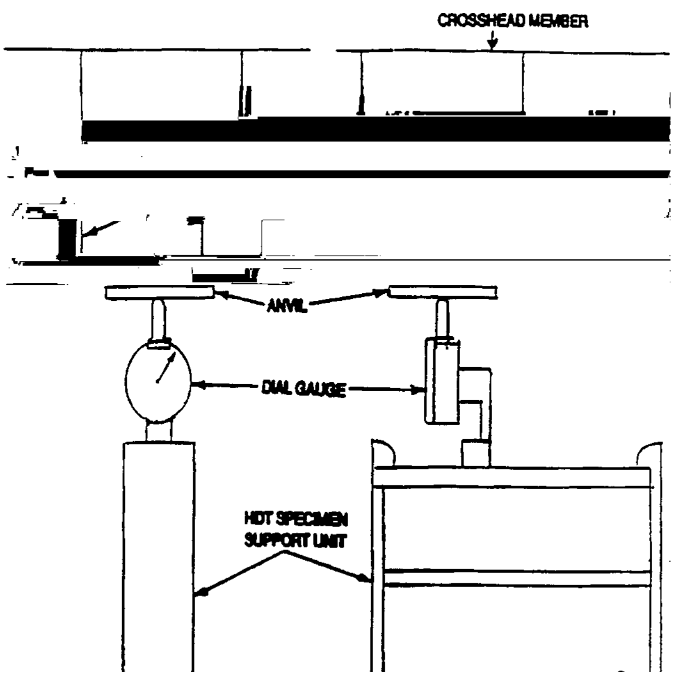

FIG. X5.1 Calibration Apparatus for Determining Spring Force

X5.2 Procedure

5.2.1 [illegible] Fig. 5.1.

5.2.2 [illegible].

5.2.3 [illegible].

5.2.4 [illegible] 0.3 [illegible] 60 [illegible].

5.2.5 [illegible].

5.2.6 [illegible]. Th[illegible]. A[illegible] 0.05 [illegible] 0.5 [illegible].

NOTE 5.1 If [illegible].

5.2.7 [illegible] Fig. 5.2 [illegible] 5.3. If [illegible] Fig. 5.2. If [illegible] Fig. 5.3.

5.2.8 [illegible]. If [illegible] 5 % [illegible] 1, [illegible].

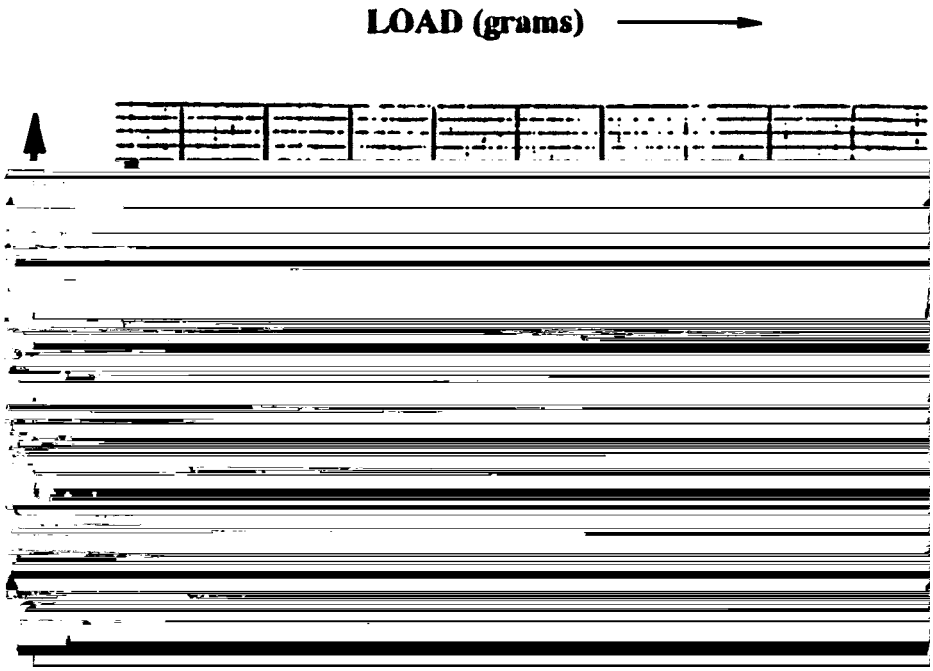

FIG. X5.2 Load Versus Deflection Curve for Gauge With No Current Problems

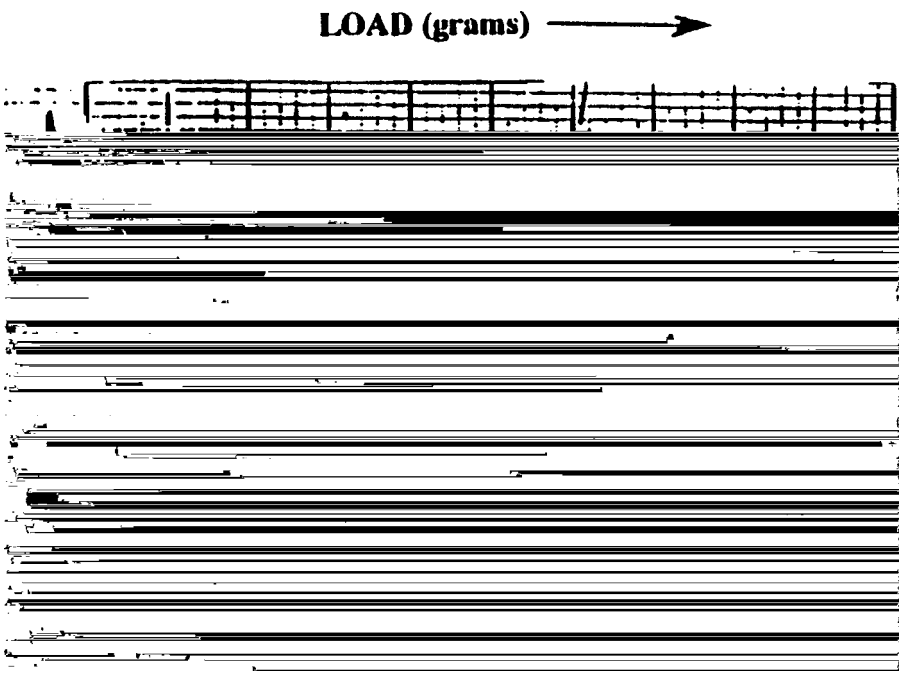

FIG. X5.3 Load Versus Deflection Curve for Gauge With Problems

SUMMARY OF CHANGES

This section has been added to identify the location of changes to this standard since the last edition (D 648 - 06) that may impact the use of this standard. (April 1, 2007)

(*1*) Added 1.4. (*2*) Revised 7.1.5.2.

This section has been added to identify the location of changes to this standard since the last edition, D 648 - 04, that may impact the use of this standard. (April 15, 2006)

(*1*) Added Annex A2. (*2*) Revised 9.1.4 and added Annex A2.