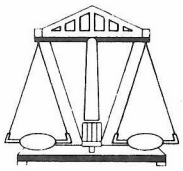
CHAPTER 7

TESTS AND TOLERANCES



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7.0 TESTS AND TOLERANCES

7.1 INTRODUCTION

The prime reference for tests and tolerances of commercial scales is NBS Handbook 44, and certain responsibilities for compliance with regulations are placed upon manufacturer and the owner/operator. The Department of Weights and Measures must be notified, as follows:

a. A scale has not been certified officially for commercial use.

b. Prior to the installation of a scale.

c. Upon completion of major reconditioning or overhaul.

d. Prior to returning an officially rejected or condemned scale to service.

To obtain the highest level of compliance with the laws and regulations affecting weights and measures, there must be cooperation between manufacturers, users and officials. The system of weights and measures must operate in a climate of integrity, trust and goodwill. The goal is honesty and equity.

7.2 TERMS/DEFINITIONS AND SYMBOLS

The following terms, definitions and symbols are applicable to this chapter.

SCALE: The word "scale" means any weighing device subject to weights and measures regulations. In this sense, "scale" and "weighing system" mean the same.

PLATFORM: "platform" is considered to be synonymous with the following terms: Load Receiving Element, Hopper, Bin, Platter, Tank or other load receptors.

The following symbols are applicable:

TERM	SYMBOL	EXAMPLE
Pounds	lbs.	10 lbs.
Division	d	3 d
Greater than	>	loads > 1000 lbs.
Equal to or greater than	$\geq$	capacity $\geq$ 5000 lbs.
Less than	<	loads < 1000 lbs.
Equal to or less than	$\leq$	capacity $\leq$ 5000 lbs.
Plus and minus	$\pm$	$\pm$ 3 d
Percent	%	% of a scale capacity

7.3 TOLERANCE APPLICATION

Tolerance values shall be applied to all indications and printed values; however, when equipment is adjusted, the adjustments shall be made to bring performance errors as close as practicable to zero value.

1. Tolerances are applied equally to plus (+) and minus (-).

2. Tolerances shall be applied independently to each indicator or printer of a scale.

3. The following requirements shall apply to analog and digital indications within the same element:

a. Analog indications within the same indicator shall agree.

b. Digital indications and printed values (tickets) shall agree. A digital value shall round off to the nearest minimum division.

c. Analog indications and printed values shall agree to the nearest minimum division.

d. Analog and digital indications shall agree at zero-load balance.

All components of the same indicator used in combination (such as dial and unit weights) shall not differ by more than the absolute value of the tolerance at any given test load.

(continued)

7.4 REPEATABILITY

At the same test load, a scale shall repeat its indications within the absolute value of the tolerance through several repeated drafts or weighings.

7.5 AGREEMENT OF SECTIONS

Agreement of sections on vehicle, livestock, and railway track scales: Individual sections must agree within the absolute value of the maintenance tolerance.

7.6 ACCEPTANCE TOLERANCE

Acceptance tolerance shall apply as follows:

a. Placed in use for the first time.

b. Placed in service within preceeding 30 days and is being officially tested for the first time.

c. Following official rejection for performance (tolerance, sensitivity, etc.) failure and being officially tested for the first time within 30 days following correction.

d. Being officially tested for the first time within 30 days following major reconditioning or overhaul.

7.7 MAINTENANCE TOLERANCE

Maintenance tolerance shall apply at all times when acceptance tolerance does not apply. (See 7.6 above)

7.8 SENSITIVITY REQUIREMENT(SR)

Applies to a non-automatic indicating (beam) scales only, and is the same value for both "acceptance" and "maintenance" tests. Except for scales 7.9 - 7.14.

The SR shall be:

a. Twice the value of the minimum division on the weighbeam.

b. 0.2 percent of the nominal capacity of the scale, or,

c. 40 pounds, whichever is least.

7.9 PRESCRIPTION SCALES

The SR shall be 0.1 grain (6 milligrams).

7.10 JEWELERS SCALES

a. With a capacity of one-half ounce or less: The SR shall be 0.1 grain (6 milligrams).

b. With a capacity of more than one-half ounce: The SR shall be the value of the minimum division of the device or 0.05 percent of the capacity of the scale, whichever is less.

7.11 DAIRY/PRODUCT-TEST SCALES

a. Used in determining butterfat content: The SR shall be 0.5 grain (32 milligrams).

b. Used in determining moisture content: The SR shall be 0.3 grain (19 milligrams).

7.12 GRAIN TEST SCALES

The SR shall be the value of the minimum division or 0.05 percent of the capacity of the scale, whichever is less.

7.13 ANIMAL/LIVESTOCK/AXLE-LOAD, AND VEHICLE SCALES

a. Not equipped with balance indicators: The SR shall be twice the value of the minimum division on the weighbeam, or 0.2 percent of nominal capacity of the scale, whichever is less.

b. Equipped with balance indicators: The SR shall be the value of the minimum division on the weighbeam.

7.14 RAILWAY TRACK SCALES

The SR shall be three times the value of the minimum division on the weighbeam, or 100 pounds, whichever is less.

7.15 TESTING

7.16 TESTING PROCEDURES

Increasing Test Load - The increasing load test shall be conducted on all scales with the test loads approximately centered on the load-receiving element of the scale, except on a scale having a nominal capacity greater than the total available known test load, in which

case the available test load is used to greatest advantage by concentrating it, within prescribed load limits over the main load supports of the scale.

7.17 DECREASING-LOAD TEST

The decreasing-load test shall be conducted on automatic indicating scales only (dial, digital) and with a test load equal to one-half of the maximum applied test load, approximately centered on the load receiving element of the scale.

7.18 SHIFT TEST

a. Bench or Counter Scales - The shift test shall be conducted with a half-capacity test load centered successively at four points equidistant between the center and the front, left, back, and right edges of the load-receiving element.

b. Vehicle Scales - The shift (section) test shall be conducted with at least two different test loads successively distributed between the two load bearings (or other weighing elements) that support each section of the scale.

c. On Railway Track Scales Weighing Individual Cars in Single Drafts - The shift (section) test shall be conducted with at least two different test loads, if available, distributed over, or to the right and left, of each pair of main levers or other weighing elements supporting each section of the scale.

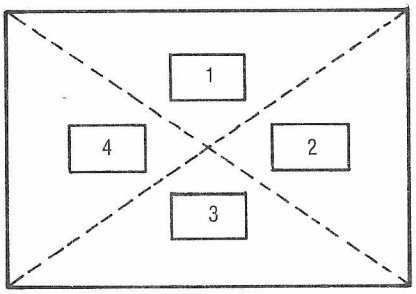
d. Equal-Arm Scales - The shift test shall be conducted with a half-capacity test load shifted, as prescribed in (a) on each pan, with an equal test load centered on the other pan.

e. Cream-Test or Moisture-Test Scales - The shift test shall be conducted with a test load of 18 grams, this load being successively positioned at all points at which a weight might reasonably be placed in the course of normal use of the scale.

f. On All Other Scales Except Crane Scales and Hanging Scales - The shift test shall be conducted on all other scales, except crane scales and hanging scales, with:

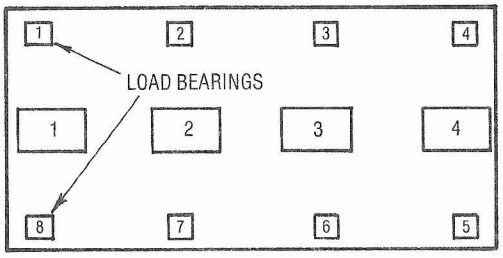
1. half-capacity test load centered, as nearly as possible, successively at the center of each quarter of the load-receiving element; or,

2. quarter-capacity test load centered, as nearly as possible, successively over each main load support.



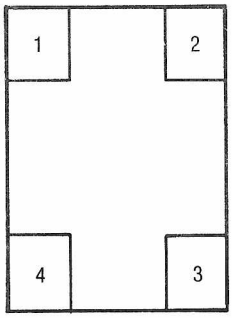
Test Load - 1/2 Capacity
Tolerance - Basic

Figure 7.1. Shift Test Bench or Counter Scales



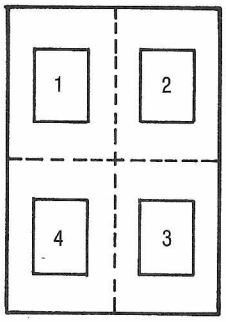
Test Load - 2 Different Test Loads Including Maximum Available Not To Exceed Sectional Capacity

Figure 7.2. Shift Test Vehicle Scales-4 Section



Test Load - 1/4 Capacity
Tolerance - Basic

Figure 7.3. Shift Test Scale



Test Load - 1/2 Capacity
Tolerance - Basic

Figure 7.4. Shift Test Scale

7.19 TEST FOR SR

The test for sensitivity shall be conducted on all beam scales at:

a. zero load, and

b. maximum test load, by either increasing or decreasing the test-weight load on the platform of the scale (see Section 7.8).

7.20 SR TEST RESPONSE

Shall be as follows:

a. Trig Loop but Without a Balance Indicator - The weighbeam shall change from a balanced equilibrium position to the top or bottom of the trig loop, depending upon whether test weight was added or removed from the platform.

b. Single Balance Indicator, Scale <500 lbs Capacity - The position of rest of a single indicator shall change at least 0.04 inch, or, at least one division on the graduated scale, whichever is greater.

c. Single Balance Indicator, Scale ≥ 500 Pounds capacity - The position of rest of a single indicator shall change at least 0.25 (1/4) inch, or, at least one division on the graduated scale (or for width of the central target area), whichever is greater. However, the indicator on a batching scale shall change at least 0.12 (1/8) inch or at least one division on the graduated scale, whichever is greater.

d. Two Opposite-Moving Balance Indicators - The position of rest of the two indicators moving in opposite directions shall change, with respect to each other, by at least 0.04 inch.

e. Scale with Neither a Trip Loop Nor a Balance Indicator - The position of rest of the weighbeam or lever system shall change from the horizontal, or midway between limiting stops, to either limit of motion.

7.21 ZONE OF UNCERTAINTY TEST

The zone of uncertainty test on digital instruments shall be conducted under conditions in which environmental factors are minimized to the extent that they will not significantly affect the results obtained.

7.22 RATIO TEST

A ratio test shall be conducted on all scales employing counterpoise weights and on nonautomatatic-indicating equal-arm scales.

7.23 MINIMUM TEST-WEIGHT LOAD FOR RAILWAY TRACK SCALES

In the test of a railway track scale, the test weight load shall be not less than 30,000 pounds.

7.24 COUPLED-IN-MOTION-TESTS

A test train shall be a train of no less than 10 cars yielding 100 car weights.

7.25 TESTING WITH NONASSOCIATED EQUIPMENT

(Walkie Talkies, C.B.'s, etc.)-Tests to determine conditions, such as RFI and EMI which may adversely affect the performance of a device shall be conducted with equipment and under conditions which are usual and customary with respect to the location and use of the device.

7.26 SCALE TOLERANCES

Tolerance values are based on General Code and Scale Code paragraphs that influence or otherwise establish limits of error for scales at various test loads. Reference National Bureau of Standards Handbook 44.

7.27 TO SECTIONAL TESTS ON VEHICLE/ LIVE STOCK/RAILROAD TRACK SCALES

The maximum deviation between indicated values on test loads applied to individual sections shall not be greater than the absolute value of the maintenance tolerance applicable to that test load (added 1977).

On the following pages Tolerance Tables are placed with information on the various types of scales discussed herein.

TABLE 7.1

RETAIL FOOD SCALES, DIGITAL, x0.01 LB

The acceptance and maintenance tolerances are applied directly to the scale indication or printed ticket value.

TOLERANCE TABLE

TEST LOAD (lbs)	ACCEPTANCE TOLERANCE ± (lbs)	TEST LOAD (lbs)	MAINTENANCE TOLERANCE ± (lbs)
>0 - 20	0.01	>0 - 7	0.01
>20 - 30	0.02	>7 - 20	0.02
Return to Zero	0.01	>20 - 30	0.03
		Return to Zero	0.01

NOTES:

1. Shift Test: Conduct at 1/2 capacity. Basic tolerances apply.

2. Decreasing-Load Test: Increase tolerance value by 0.01 lb for 1/2 capacity test load.

TABLE 7.2

RETAIL FOOD SCALES, DIGITAL, x0.005 LB

The acceptance and maintenance tolerances are applied directly to the scale indication or printed ticket value.

TOLERANCE TABLE

TEST LOAD (lbs)	ACCEPTANCE TOLERANCE ± (lbs)	TEST LOAD (lbs)	MAINTENANCE TOLERANCE ± (lbs)
>0 - 7	0.005	>0 - 2	0.005
>7 - 20	0.010	>2 - 7	0.010
>20 - 30	0.015	>7 - 10	0.015
		>10 - 15	0.020
		>15 - 20	0.025
		>20 - 30	0.030
		Return to Zero	0.005

NOTES:

1. Shift Test: Conduct at 1/2 capacity. Basic tolerances apply.

2. Decreasing-Load Test: Increase tolerance value by 0.005 lb for 1/2 capacity test load.

TABLE 7.3

RETAIL FOOD SCALE, ANALOG, CAPACITY
30 LBS

The acceptance and maintenance tolerances are applied directly to the scale indication as corrected by use of error weights.

TEST LOAD (lbs)	ACCEPTANCE TOLERANCE ± (ozs)	TEST LOAD (lbs)	MAINTENANCE TOLERANCE ± (ozs)
>0 - 20	3/16	>0 - 7	3/16
>20 - 30	1/4	>7 - 10	1/4
Return to Zero	3/16	>10 - 15	5/16
		>15 - 20	3/8
		>20 - 30	1/2
		Return to Zero	3/16

NOTES:

1. Shift Test: Conduct at 1/2 capacity. Basic tolerances Apply.

2. Decreasing-Load Test: Increase tolerance value by 1/8 oz for 1/2 capacity test load.

TABLE 7.4

VEHICLE, AXLE-LOAD, CRANE, HOPPER SCALES
CAPACITY ≤ 200,000 x 20 LBS

The acceptance and maintenance tolerances are applied directly to the scale indication or printed ticket value.

TOLERANCE TABLE

TEST LOAD (lbs)	ACCEPTANCE TOLERANCE ± (lbs)	TEST LOAD (lbs)	MAINTENANCE TOLERANCE ± (lbs)
0 - 20,000	20	0 - 10,000	20
40,000	40	20,000	40
60,000	60	30,000	60
80,000	80	40,000	80
100,000	100	50,000	100
120,000	120	60,000	120
140,000	140	70,000	140
160,000	160	80,000	160
180,000	180	90,000	180
200,000	200	100,000	200
Return to Zero	20	Return to Zero	20

NOTES:

1. For test loads between those shown above, the smaller tolerance value shall apply.

2. Section Test: Conduct at two test loads (for vehicle scale tests). Sections must agree within value of maintenance tolerance.

3. Decreasing-Load Test: Increase tolerance value by 50% for 1/2 maximum applied test load.

TABLE 7.5

VEHICLE SCALE - CAPACITY 200,000 x 50 LBS

The acceptance and maintenance tolerances are applied directly to the scale indication or printed ticket value.

TOLERANCE TABLE - VEHICLE SCALE, DIGITAL, CAPACITY 200,000 LBS

TEST LOAD (lbs)	ACCEPTANCE TOLERANCE ± (lbs)	TEST LOAD (lbs)	MAINTENANCE TOLERANCE ± (lbs)
0 - 50,000	50	0 - 25,000	50
100,000	100	50,000	100
150,000	150	75,000	150
200,000	200	100,000	200
250,000	250	125,000	250
300,000	300	150,000	300
350,000	350	175,000	350
400,000	400	200,000	400
450,000	450	225,000	450
500,000	500	250,000	500
Return to Zero	50	Return to Zero	50

NOTES:

1. For test loads between those shown above, the smaller tolerance value shall apply.

2. Section Test: Conduct at two loads.
   Section must agree within value of maintenance tolerance.

3. Decreasing Load Test: Increase tolerance value by 50% for 1/2 maximum applied test load.

TABLE 7.6

LIVESTOCK SCALE, ANALOG, x5 LBS

Acceptance and maintenance tolerances are applied directly to the scale indication, after correction, by use of error weights. (Amount of error weights needed to obtain equilibrium determines scale error at each test load).

TOLERANCE TABLE

TEST LOAD (lbs)	ACCEPTANCE TOLERANCE ± (lbs)	TEST LOAD (lbs)	MAINTENANCE TOLERANCE ± (lbs)
0 - 5,000	5	0 - 2,500	5
10,000	10	5,000	10
15,000	15	7,500	15
20,000	20	10,000	20
Return to Zero	5	12,500	25
		15,000	30
		17,500	35
		20,000	40
		Return to Zero	5

NOTES:

1. For test loads between those shown above, the smaller tolerance value shall apply.

2. Corner Test:
   Test load shall not exceed 1/4 scale capacity.

3. Section Test:
   Conduct at load not exceeding section capacity. Sections must agree within value of maintenance tolerance.

4. Sensitivity Test:
   Determine sensitivity at zero load and maximum test load.

TABLE 7.7

INDUSTRIAL SCALE, DIGITAL, DIAL/PRINTER,
10,000 x 2 LB

The acceptance and maintenance tolerances are applied directly to the printed ticket value.

TOLERANCE TABLE

TEST LOAD (lbs)	ACCEPTABLE TOLERANCE ± (lbs)	TEST LOAD (lbs)	MAINTENANCE TOLERANCE ± (lbs)
0 - 2,000	2	0 - 1,000	2
4,000	2	2,000	2
6,000	3	3,000	3
8,000	4	4,000	4
10,000	5	5,000	5
Return to Zero	2	6,000	6
		7,000	7
		8,000	8
		9,000	9
		10,000	10
		Return to Zero	2

NOTES:

1. For test loads between those shown above, the smaller tolerance value shall apply.

2. Shift Test:
   Conduct at 1/2 capacity with test load successively at center of each quarter of platform. (or, 1/4 capacity over load supports).

3. Decreasing-Load Test:
   Increase tolerance value by 50% for 1/2 maximum applied test load.

APPENDIX A

GENERAL DEFINITIONS