Chapter 6

Test

Objectives

In this chapter you will learn how the Test portion of the scale examination of vehicle and axle-load scales should be conducted. After studying this chapter, you should be able to:

1. Describe additional requirements in Handbook 44 relating to the Test of vehicle and axle-load scales.

2. Describe procedures for conducting the various tests prescribed in the EPOs.

It is recommended that you remove the copies of EPOs 13 and 13-E from Appendix B at the back this manual and turn to the Test sections, so that you can follow the step-by-step outlines as you study the material in the chapter.

General Considerations

After the tolerances have been determined for the specific scale being examined, you should begin the Test portion of the examination. The Test should be performed in a deliberate and organized manner. Following the sequence outlined in EPO No. 13 and EPO No. 13-E will make efficient use of your time in performing the Test. Results of each test should be recorded on an appropriate report form as the test progresses. In testing a scale, you should follow the EPO step-by-step. If a test is interrupted for a commercial weighing, check zero-load balance and then resume the test where it was interrupted.

Using small test weights called **error weights** can make testing a beam scale easier and more efficient. Their use allows you to determine on a pass/fail basis if the scale error is in or out of tolerance. This ability is especially useful on large-capacity scales.

The procedure for using error weights is as follows:

1. Use the completed tolerance worksheet for the scale to be tested to aid in choosing the correct values of error weights.

    - Choose weights that together will equal the maximum tolerance value. For example, if the largest test load will be 30,000 lb on a maintenance test of a scale with 20-lb scale divisions, the maximum tolerance will be 3 d, or 60 pounds; the total of error weights should therefore be 60 pounds.

    - Make the selection so that the smallest error weight is equal to the minimum tolerance value (in the example just used, this would be 1 d, or 20 lb), and the total value of the weights is equal to the tolerance value at the maximum test load.

2. Place all error weights from the group on the load-receiving element of the scale.

3. Bring the scale to zero-load balance with the error weights on the scale, using whatever means is normally used to obtain a zero-load balance.

4. Conduct the test (using tolerance testing as the test method). Add a test load to the deck and move the poise to the position on the beam that corresponds to the test load. Check the beam for balance. If not balanced, then add or subtract error weights as necessary, but not to exceed the value of the tolerance for the test load in question. If either the addition or subtraction of error weights fails to bring the scale at least into balance, it is out of tolerance at that point.

5. After the test, remove error weights and counterbalance materials, and bring the scale back into balance for regular use.

Using error weights on scales equipped with mechanical dials is not recommended because dials are not responsive to very small changes in load. However, some experienced weights and measures inspectors find that error weights make it easier to determine whether small errors are within tolerance. Larger errors may easily be read directly from the dial.

If error weights are used with dial scales, they must be applied to the deck before the test begins. The procedure is the same as with beam scales, as described above, with one exception. A change in error weight must be accompanied by removing and replacing a large amount of weight at each error weight change. This technique helps to overcome the inertia of the dial mechanism. For example, a 500-lb test weight might be removed at the same time as the error weight corresponding to the applicable tolerance for a test; the large weight would then be returned to the scale.

Sensitivity Requirement (SR) at Zero- Load *(Beam Scales Only)*

When a small change is made in the load on a scale, the scale should be able to respond by giving a reasonably precise reading. This ability is called **sensitivity**. In this test of the sensitivity of the scale, you determine the change in load that is needed to move the indicating element away from its position of rest by a definite amount. The test is conducted at zero load and at the maximum test load. The requirements for this test were identified during pretest determinations; they are summarized in Figure 4-2.

The scale should be in the following condition before starting the SR at Zero-Load Test:

- error weights, selected as described above, placed on the load-receiving element (deck);
- error weights counterbalanced;
- beam in balance, tip of beam oscillates equal distances above and below horizontal;

Remove error weights equal to the SR test load from the deck:

- for scales with balance indicators, 1d
- for all other nonautomatic-indicating scales, 2d or 0.2 percent of the scale capacity, whichever is less

The change in balance of the beam must be as follows:

- for scales with balance indicators, the greater of:
  - change in position of 0.25 inch for unmarked scales, 0.2 inch for marked scales, or
  - one graduation, or
  - the width of the target area
- for scales with trig loop but no balance indicator, the beam tip must move from the center of the trig loop and come to rest at the top or bottom
- for scales with neither trig loop nor balance indicator, the beam or lever system moves to its limit of motion

If the specified change does not occur, the scale does not meet the sensitivity requirement.

The SR test may also be performed by adding the SR test load to the scale and observing the change in the balance of the beam. A beam may meet the SR requirement when weights are removed but fail to meet it when weights are added (or vice versa); therefore, it is recommended that you conduct the test both ways (unless the beam fails the first SR test).

Increasing-load and Shift Tests

The Increasing-Load Test determines whether the scale weighs accurately when a series of weights is successively added to the load-receiving element. This is the basic test of scale performance, and is conducted on all vehicle and axle-load scales. However, the sequence in which test loads are applied varies with the type of scale, as described below.

> **N.1.1. Increasing-Load Test.** — 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. When the total test load is less than the nominal capacity, the test load is used to greatest advantage by concentrating it, within prescribed load limits, over the main load supports of the scale.

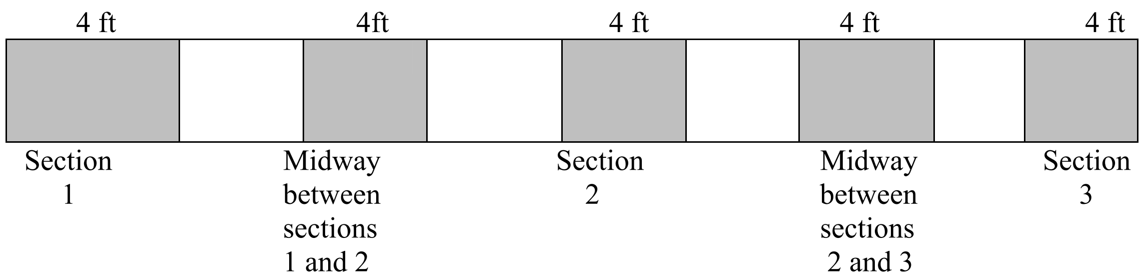
Handbook 44 Scales Code, Paragraph N.1.1.

The Shift Test, which is performed during the Increasing-Load Test, tests the ability of the scale to accurately weigh loads that are not directly centered over the load-receiving element. This test is particularly relevant to vehicle and axle-load scales, since in normal use the load is concentrated on a relatively small portion of the scale deck.

N.1.3.4.1. Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales:

(a) Minimum Shift Test. At least one shift test shall be conducted with a minimum test load of 12.5 percent of scale capacity and may be performed anywhere on the load-receiving element using the prescribed test patterns and maximum test loads specified below. (Combination Vehicle/Livestock scales shall also be tested consistent with N.1.3.4.2.)

(b) Prescribed Test Pattern and Loading for Vehicle Scales, Axle-Load Scales and Combination Vehicle/Livestock Scales. The normal prescribed test pattern shall be an area of 1.2 m (4 ft) in length and 3.0 m (10 ft) in width or the width of the scale platform, whichever is less. Multiple test patterns may be utilized when loaded in accordance with Paragraph (c), (d), or (e) as applicable.



(c) Loading Precautions for Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales. When loading the scale for testing, one side of the test pattern shall be loaded to no more than half of the concentrated load capacity or test load before loading the other side. The area covered by the test load may be less than 1.2 m (4 ft) x 3 m (10 ft) or the width of the scale platform whichever is less; for test patterns less than 1.2 m (4 ft) in length the maximum loading shall meet the formula: [(wheel base of test cart or length of test load divided by 48 in) x 0.9 x CLC]. The maximum test load applied to each test pattern shall not exceed the concentrated load capacity of the scale. When the test pattern exceeds 1.2 m (4 ft), the maximum test load applied shall not exceed the concentrated load capacity times the largest "r" factor in Table UR.3.2.1. for the length of the area covered by the test load. For weighing elements installed prior to January 1, 1989, the rated section capacity may be substituted for concentrated load capacity to determine maximum loading. An example of a possible test pattern is shown above.

(d) Multiple Pattern Loading. To test the nominal capacity, multiple patterns may be simultaneously loaded in a manner consistent with the method of use.

(e) Other Designs. Special design scales and those that are wider than 3.7 m (12 ft) shall be tested in a manner consistent with the method of use but following the principles described above.

Handbook 44 Scales Code, Paragraph N.1.3.4.1.

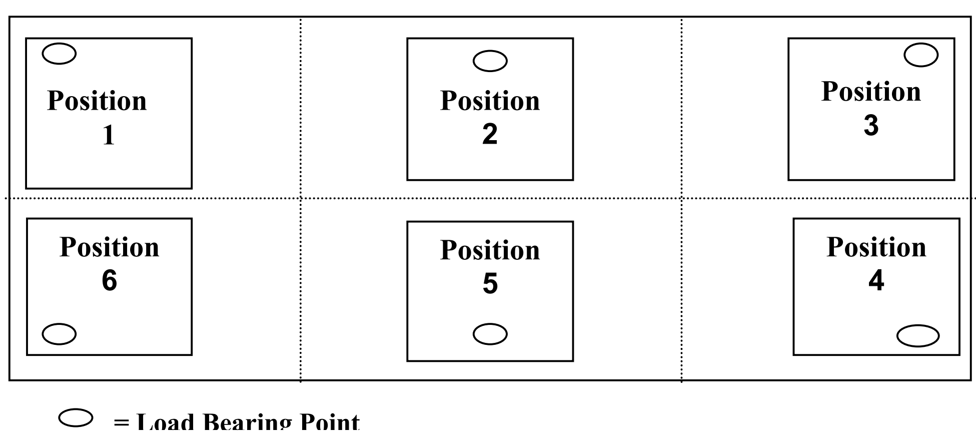
Specific minimum and maximum test load requirements and loading precautions for the shift test are described in N.1.3.4.1. These must be carefully observed. Test loads should be evenly applied and distributed over the test pattern, with no more than one half of the CLC applied to one side of the test pattern before loading the other side. At least one shift test shall be conducted using a minimum test load of 12.5 percent of scale capacity. The test load can be placed anywhere on the load-receiving element providing it is distributed evenly over the test load pattern.

Historically a shift test using two different test loads was recommended, providing a more complete test and improving performance analysis. Handbook 44 does not limit the shift test to a single load and this module provides instruction on conducting a shift test using two different loads.

The precise dimensions, length, and width of the test load pattern are stated in the requirement and allows for the loading of test loads up to the marked CLC. However, if the test load pattern is less than or greater than the dimensions stated, then the CLC for that test pattern must be calculated. For test load patterns less than 1.2m (4 ft) in length x 3.0m (10 ft) in width, or the width of the platform, whichever is less, the maximum loading must conform to the formula: [(wheel base of test cart or length of test load divided by 48 in) x 0.9 x CLC]. When the length of the actual test pattern is greater than the length of the prescribed test pattern, the maximum test load shall not exceed: CLC x “r” factor. The “r” factor is determined from Table UR.3.2.1. In addition, N.1.1. reads that when the test load is less than the nominal capacity, it is applied with the greatest advantage over the load supports. Loading at the section tests for proper adjustment of the levers or load cells in each section. Loading at midspan tests for performance changes due to deflection in the deck supports.

Before beginning the Increasing-Load and Shift Test, plan your strategy to make best use of the available test weights while adhering to loading precautions described above. Plan the test sequence to minimize the number of times the test weights need to be moved.

N.1.3.4.2. Prescribed Test Pattern and Test Loads for Livestock Scales with More Than Two Sections and Combination Vehicle/Livestock Scales. A minimum test load of 5000 kg (10,000 lb) or one-half of the rated section capacity, whichever is less, shall be placed, as nearly as possible, successively over each main load support as shown in the diagram below. For livestock scales manufactured between January 1, 1989, and January 1, 2003, the required loading shall be no greater than one-half CLC. (Two-section livestock scales shall be tested consistent with N.1.3.8.)



Handbook 44 Scales Code, Paragraph N.1.3.4.2.

The shift test described in N.1.3.4.2 shall be conducted in conjunction with the shift test described in N.1.3.4.1. to test combination vehicle/livestock scales having more than 2 sections. A combination vehicle/livestock scale is a vehicle scale that has been adapted, typically by adding stock racks and gates, for use in weighing both vehicles and livestock. This additional test of a combination use scale is necessary because livestock, when loaded onto a scale platform, most often gather towards the outer edges of the platform rather than in the middle. This test best simulates actual use of such a scale.

Increasing-Load and Shift Tests for Beam Scales

The test sequence that follows is based on the scale data and available test weights used in Example 1 (Figure 4-3) in Chapter 4. You may wish to review the tolerance worksheet as the sequence is described. However, keep in mind that weighbeam scales with different capacities will have different test loads.

After placing sufficient error weights at the center of the scale platform to equal the maximum tolerance value for the scale under test, and balancing the scale, test loads are applied in accordance with the prescribed loading pattern and maximum load limits described above.

When testing a weighbeam with a fractional bar, test weights should be applied first to test the bar at approximately one-half and full capacity. Since the fractional bar in Example 1 had a capacity of 990 lb, weighings would be made with loads of 500 and 990 lb. Record the registered weights and perform all required Test Notes procedures after each weighing. If the weight is close to but outside the acceptable range of scale indication, as shown on the worksheet, you should repeat the test.

After testing the fractional bar, continue the Increasing-Load Test, adding test weights up to each of the tolerance break points and recording indications at those points. In Example 1, these were 5,000-lb increments up to the limit of the available test weights (30,000 lb). For the Shift Test, a weighing should also be made with a test load equal to one-half the section capacity or CLC or one-half the available test weights, whichever is less. In our example, one-half the available test weights (15,000 lb) was less than one-half the section capacity (25,000 lb), and coincided with a tolerance break point. In a situation in which this is not the case, a separate weighing should be performed for the Shift Test.

Your jurisdiction may not have weights in increments that would allow you to follow this type of progression. If not, remember that whenever possible you should try to apply a test load that is at the upper limits of a tolerance range; this provides the most stringent test of the scale's accuracy. For example, the range of test loads to which a tolerance of 2 d is applied is 501 d to 1000 d; in this case, you should select weights equal to 1000 d or as close as possible to that amount without exceeding 1000 d (which would put you into the lower limits of the next tolerance range).

When the test load has reached one-half the CLC, section capacity, or available weights, move the load to each of the remaining sections and record weighings. It is recommended that you also record weighings at the midpoint between sections or at least at one midpoint (if there is a difference in the distance between the sections, you should test at the midpoint between the sections with the greatest distance between them).

Caution: When testing scales not marked with the concentrated load capacity (i.e., the scales were installed before 1989 and are marked with the section capacity), the loads placed directly over the sections may equal the section capacity; however, loads placed midway between sections should be limited to 80 percent of the section capacity. If two weight carts are used, they should travel along the paths the wheels of a vehicle would take when moving across the scale. Decreasing-load tests are to be avoided when testing a section. This means a truck should not be backed onto the scale to put weights on the inner sections and then driven off.

As you perform the shift test, keep in mind the requirement that the range of results obtained may not exceed the absolute value of the maintenance tolerance (T.N.4.4.). Even if this value is exceeded before you finish the test, you should complete the test in order to develop a complete set of performance data for the scale. Each indication recorded during the shift test must also be within the applicable tolerance. In Example 1, the test load is 15,000 lb, so the individual shift test results must conform with the tolerance of ± 30 lb; in addition, the difference between the highest and lowest indications can not be more than 30 lb.

After recording the final weight at one-half CLC or section capacity or one-half available test weight, continue with the Increasing-Load Test, proceeding, again, from one tolerance break point to the next. In our example, the section capacity is greater than the available test weights, so you would not need to start another test pattern. Remember that the applied load on any test pattern must not exceed the CLC or section capacity.

You should perform another Shift Test at full section capacity if you have sufficient test weights; if not, the second shift test should be conducted with the total certified test load (30,000 lb in the case of Example 1). At the completion of the Shift Test, remove all test load from the scale, check zero-load balance, and record any change.

If you have reached section capacity or CLC but not scale capacity and still have additional test weights, continue the Increasing-Load Test. Add load in tolerance break point increments up to scale capacity or the limit of available test weights, distributing the total weight load as illustrated in Figure 6-1, without exceeding sectional capacity or CLC.

Increasing-Load and Shift Tests for Dial Scales

Example 2 in Chapter 4 (Figure 4-4) illustrates a typical test sequence for the Increasing-Load and Shift Tests on scales equipped with mechanical dial indicators; you should review the worksheet after reading this section to make sure that you understand the test sequence. Note that this example employs acceptance tolerances, and that the tolerance for the range of results on the Shift Test is the absolute value of the applicable maintenance tolerance.

The only major difference in the test is in the sequence of test loads:

- Tests are conducted at load increments of one-quarter the dial capacity, up to full capacity. In our example, these increments coincide with tolerance break points.

- Tests are also conducted at each unit weight (in this example, the available test weights were less than two unit weights, so only one was tested).

In other respects, procedures for these tests are identical to those for scales equipped with weighbeams, except, as suggested above, error weights should not be used on this type of scale.

Increasing-Load and Shift Tests for Electronic Digital Indicating Scales

Review Examples 3 and 4 in Chapter 4 for the sequence of test loads in the Increasing-Load and Shift Tests of a scale equipped with an electronic digital indicator. You will see that weights are recorded only at tolerance break points, and the Shift Tests are conducted at the one-half and full CLC or section capacity or available test loads.

Before beginning the Increasing-Load and Shift Tests, establish the zero balance condition as follows:

1. If the power switch is ON, turn it OFF prior to the start of the test. (However, always check first with the device owner/operator before turning a device off, to be sure that your action will not have negative consequences — for example, erasing information stored in the device's memory.)

2. On some scales, when the power goes on, a segment test will be displayed. At first, the numeral 8 will show in each column. The numerals will then cycle down to a zero weight indication. If there is a printer, check to be sure it has the proper paper in it, then push the PRINT button. The printer should not print a weight value until the indicator has warmed up (applies to indicators manufactured after January 1, 1981).

3. If the scale has an automatic zero-setting mechanism, go on to the Test of Automatic Zero-Setting Mechanism, described later in this chapter.

RFI/EMI Test

Scales, like other weighing and measuring devices, must be designed, installed, used, and maintained in such a manner that they can perform within specified tolerances regardless of environmental conditions which may be encountered in service, including the effects of associated and nonassociated equipment and of Electromagnetic Interference (EMI) or a type of EMI called Radio Frequency Interference (RFI) that may be generated by that equipment or by other environmental sources.

G-UR.3.2. Associated and Nonassociated Equipment. — A device shall meet all performance requirements when associated or nonassociated equipment is operated in its usual and customary manner and location. (Added 1976)

G-UR.4.2. Abnormal Performance. — Unstable indications or other abnormal equipment performance observed during operation shall be corrected and, if necessary, brought to the attention of competent service personnel. (Added 1976)

G-UR.1.2. Environment. — Equipment shall be suitable for the environment in which it is used including, but not limited to, the effects of wind, weather, and radio frequency interference (RFI). (Added 1976)

Handbook 44 General Code, Paragraphs
G-UR.3.2., G-UR.4.2., G-UR.1.2.

If during the testing of an electronic scale you observe a number of erratic readings, the problem may be caused by EMI. The test to determine the performance of the scale system in the presence of EMI consists of applying a test load to the load-receiving element and operating, one at a time, all electrical equipment in the vicinity of the scale, including, but not limited to, lighting systems, office equipment, appliances, vending machines, motors and generators, communications equipment (portable, fixed base, mobile), closed circuit TV systems. Walkie-talkies or other radio-transmitting devices may be the source of RFI. If these devices are commonly found in the area around the scale, they should be included in the test. When conducting an RFI test, use the equipment found on site and operate it in a manner consistent with normal use.

The RFI/EMI test should be performed with the same test load under two sets of conditions:

- With as many items of equipment of the type listed above as are normally operated on-site shut OFF.
- With as many of these items as are normally in use on the site switched ON, one at a time.

G-N.2. Testing with Nonassociated Equipment. — Tests to determine conditions, such as RFI, that may adversely affect the performance of a device shall be conducted with equipment and under conditions that are usual and customary with respect to the location and use of the device.
(Added 1976)

N.1.6. RFI Susceptibility Tests, Field Evaluation. — An RFI test shall be conducted at a given installation when the presence of RFI has been verified and characterized if those conditions are considered "usual and customary."
(Added 1986)

Handbook 44 General Code, Paragraph G-N.2. and
Scales Code, Paragraph N.1.6.

Indicating elements should be observed closely as equipment is switched on, to see if indications are affected. If possible, a ticket should be printed when all items are off and another when all items are on. If the performance of the scale appears to be affected by any of the tests, the device suspected of causing the interference should be turned on and off to verify that it is the source of the problem, while you observe the effects.

Compare the scale indication with the equipment turned off to the indication with the equipment turned on. The difference between the two indications must not exceed one scale division or the scale must be designed to make the indications or recorded representations unreadable or to provide an error message as required by T.4. (unmarked scales) or T.N.9. (marked scales).

T.4. Radio Frequency Interference (RFI) and other Electromagnetic Interference Susceptibility. — The difference between the weight indication with the disturbance and the weight indication without the disturbance, shall not exceed one scale division (d) or the equipment shall:

(a) blank the indication, or

(b) provide an error message, or

(c) the indicator shall be so completely unstable that it could not be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.

(Added 1986)

T.N.9. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility. - The difference between the weight indication due to the disturbance and the weight indication without the disturbance shall not exceed one scale division (d); or the equipment shall:

(a) blank the indication, or

(b) provide an error message, or

(c) the indication shall be so completely unstable that it cannot be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.

The tolerance in T.N.9. is to be applied independently of other tolerances. For example, if indications are at allowable basic tolerance error limits when the disturbance occurs, then it is acceptable for the indication to exceed the applicable basic tolerances during the disturbance.
(Amended 1997)

Handbook 44 Scales Code, Paragraphs T.4. and T.N.9.

The RFI/EMI test is a supplemental test. It may be conducted at any time during a scale test, except when the scale is at zero load. EPO 13-E recommends conducting the test at the maximum load applied during the Increasing-Load Test.

Decreasing-load Test *(Automatic-Indicating Scales Only)*

Some automatic-indicating scales perform differently when a load is removed from the deck than they do when the load is applied. This is because mechanical elements that are strained when the load is applied (for example, springs in dial indicators and strain gauges in electronic systems) do not return immediately to their pre-strain condition. The Decreasing-Load Test determines how a scale responds to the removal of a load.

N.1.2. Decreasing-Load Test (Automatic Indicating Scales). — The decreasing-load test shall be conducted with the test load approximately centered on the load-receiving element of the scale.

* * *

N.1.2.2. All Other Scales. - On all other scales, except for portable wheel load weighers, the decreasing-load test shall be conducted with a test load equal to one-half of the maximum load applied in the increasing-load test.
(Amended 1998)

Handbook 44 Scales Code, Paragraphs N.1.2. and N.1.2.2.

After performing the Increasing-Load Test and Shift Test, and such special tests as the RFI/EMI Test conduct the Decreasing-Load Test by removing test weights down to one-half the maximum test load applied in the Increasing-Load Test. In removing weights, choose those that will leave the remaining load centered on the platform.

Strain-load Test

When available test weights are less than maximum capacity of a vehicle or axle-load scale, another means must be found to test the upper portion of the scale's capacity. A recommended method is the Strain-Load Test, in which a loaded vehicle or other heavy load adds weight to the scale, but does not really serve as a test weight.

One method of conducting the Strain-Load Test is as follows. First, observe the usual traffic pattern of the scale. If the scale has a single access, and vehicles drive on, are weighed, and back off, then the end of the scale nearest the access is subjected to heavy loads more frequently. This is a good place to conduct the Strain-Load Test; however, it may be conducted anywhere on the scale.

Select a load (for example, a vehicle loaded with sand) with an approximate weight such that the combined weights of the load plus the known test weights will reach or exceed the used capacity of the scale (but not exceed the nominal capacity).

Place the unknown load on the scale. Use error weights to find a reference point within the scale division for the beginning of the test. Add known test weights in one or more steps. The load may be distributed evenly over the scale platform or in a pattern approximating the axle configuration of the vehicles normally weighed on the scale. Care should be taken to avoid exceeding the CLC within any 4-foot area (or the section capacity, if you are testing an older scale). The weight value displayed may not differ from the recorded weight of the strain load plus the test weight value by more than the tolerance applicable to the test weights only.

Sensitivity Requirement (SR) at Maximum Test Load *(Beam Scales Only)*

For beam scales, the sensitivity of the scale must be checked at maximum load. The procedure is the same as that described earlier in this chapter for testing sensitivity at zero-load.

Discrimination

According to the EPOs for vehicle and axle-load scales, Discrimination Tests are optional field tests that you may want to conduct if you detect a problem that may be the result of improper discrimination, for example, an electronic indicator that is producing a number of unstable indications. These tests should only be conducted in the field if environmental factors such as wind, rain, and vibration will not affect the results.

> ***N.1.5. Discrimination Test.*** *— A discrimination test shall be conducted on all automatic indicating scales with the weighing device in equilibrium at zero load and at maximum test load, and under controlled conditions in which environmental factors are reduced to the extent that they will not affect the results obtained.* [Nonretroactive as of January 1, 1986.] (Added 1985)
>
> **N.1.5.1. Digital Device.** — On a digital device, this test is conducted from just below the lower edge of the zone of uncertainty for increasing load tests, or from just above the upper edge of the zone of uncertainty for decreasing-load tests.

Handbook 44 Scales Code, Paragraphs N.1.5. and N.1.5.1.

According to N.1.5., the tests may be conducted on analog automatic indicating scales manufactured or put into service for the first time after January 1, 1986 (in other words, all marked scales). Table T.1.1. specifies that the discrimination test requirements (T.N.7.2.) are applicable to unmarked as well as marked digital automatic-indicating scales.

The purpose of the Discrimination Test is:

- for analog indicating scales, to assure that the scale is sensitive to small changes in load;
- for electronic indicating scales, to verify that the zone of uncertainty is less than or equal to 0.3d.

> **T.N.7. Discrimination.**
>
> **T.N.7.1. Analog Automatic Indicating (i.e., Weighing Device with Dial, Drum, Fan, Etc.).** A test load equivalent to 1.4d shall cause a change in the indication of at least 1.0d. (See N.1.5.)
>
> **T.N.7.2. Digital Automatic Indicating.** — A test load equivalent to 1.4d shall cause a change in the indicated or recorded value of at least 2.0d. This requires the zone of uncertainty to be not greater than 0.3 times the value of the scale division. (See N.1.5.1.)

Handbook 44 Scales Code, Paragraph T.N.7.

The method of testing discrimination for both types of scales follows.

For Analog Automatic-Indicating Scales

Test for discrimination at least at zero load and at the maximum test weight. Apply a test load of 1.4 d (for example, if d = 10 lb, apply 14 lb). Check the weight display. If the indication has not to changed by at least 1.0 d (in this example, 10 lb) the scale fails to meet the requirements of the Discrimination Test.

Note that this test also should be performed on scales with balance indicators that have graduations with specific values.

For Digital Automatic-Indicating Scales

On a digital indicating scale, the zone of uncertainty is the range of weight of applied load over which the device may display either of the adjacent scale division values, as illustrated in Figure 6-1. To understand the concept of the zone of uncertainty for digital scale indicators, it may be helpful to think about a similar concept in mechanical scales.

On a mechanical scale, if the pointer is somewhere between two graduations, it is up to the operator to decide which value it is indicating. If the pointer is between 8170 lb and 8180 lb, but closer to 8170 lb, the operator will probably decide 8170 lb is the weight shown. If the pointer is between those graduations but closer to 8180 lb, the operator will conclude the weight is 8180 lb. If the pointer is just about halfway between the two marks, however, the operator has a harder time deciding which weight is correct. Sometimes the operator may call it one way, sometimes the other.

A digital indicator must, in effect, make those tough calls. If it prints weights to 10 lb, and the load weighs somewhere between 8170 lb and 8180 lb, somehow the digital indicator must "decide" which value to display. That "gray area," the portion of the zone halfway between scale divisions in which the digital indicator may sometimes display one value and sometimes the other, is known as the zone of uncertainty. The width of the zone of uncertainty may not exceed 0.3 d.

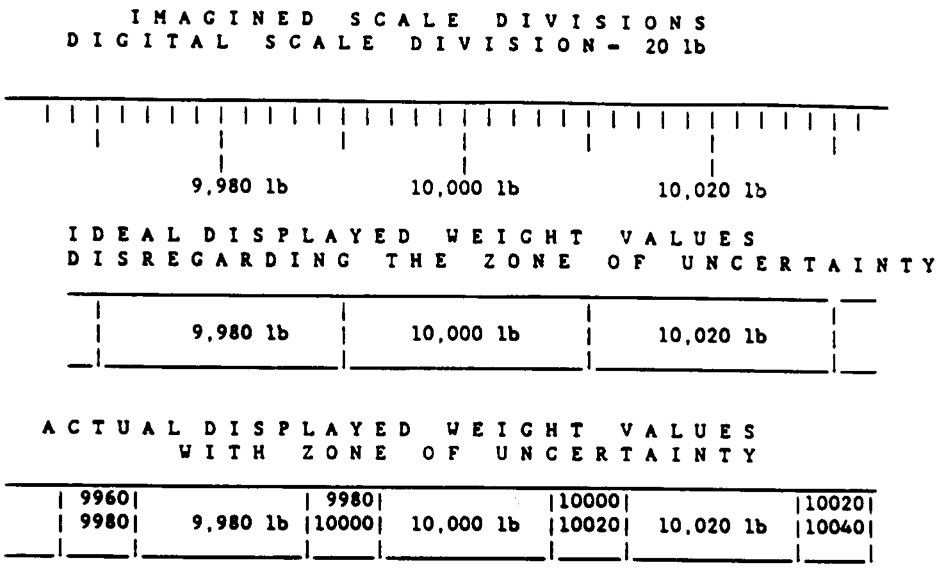


Figure 6-1.

The test for proper discrimination (that is, acceptable width of the zone of uncertainty) may be conducted at both zero and maximum test loads. When conducting a Discrimination Test at zero load:

1. At zero load (or just above the zero tracking range of the device if it is so equipped) add weights in steps of 0.1 d until you just reach the zone of uncertainty. The zone of uncertainty is detected by an occasional flickering of the display from the initial weight value to the next higher weight value with no change in weight on the scale. Then remove 0.1 d of weight to cause the reading to become stable just below the edge of the zone of uncertainty (conducting the test from just below the zone of uncertainty when adding weights is specified in N.1.5.1.).

2. Add a test load of 1.4 d (for example, on a scale with 10-lb scale divisions, apply 14 lb).

3. Check the indicator. If the value indicated is not equivalent to at least 2 d, the scale fails to meet the requirement for discrimination.

When conducting the test at the maximum test load:

1. With the maximum test load applied to the scale, remove error weights in steps of 0.1 d until you just reach the zone of uncertainty. The zone of uncertainty (again, indicated by flickering of the display from the initial weight value to the next lower weight value with no change in weight on the scale). Then add 0.1 d weight to cause the reading to become stable just above the edge of the zone of uncertainty (per N.1.5.1.).

2. Remove a test load of 1.4 d.

3. That amount of reduction of load must cause the indicated value to change by at least 2 d.

Test of Automatic Zero-Setting Mechanism *(Electronic Indicating Only)*

This test is intended to insure that an automatic zero-setting mechanism (AZSM) cannot be used to rezero the scale when there is a significant load on the scale deck (significant relative to a normal service load).

> ***S.2.1.3. Scales Equipped with an Automatic Zero-Setting Mechanism.*** *— Under normal operating conditions the maximum load that can be "rezeroed" when either placed on or removed from the platform all at once, shall be:*
>
> * * *
>
> *(b) for vehicle, axle-load, and railway track scales: 3.0 scale divisions.*
>
> *[Nonretroactive and enforceable as of January 1, 1981.]*

Scales Code, Paragraph S.2.1.3.

It is often difficult to determine if a digital electronic indicator has an automatic zero-setting mechanism. Assume there is an automatic zero-setting mechanism and proceed with the test. If there is not an AZSM, it will be disclosed by the test.

There may or may not be an ON-OFF switch for such a mechanism visible from the operator's position. Check with the owner, and if the system has an ON-OFF switch for the AZSM, turn the switch to ON. Choose test weights equal to 4 d. (For example: weights equal to 4 scale divisions, or 80 lb when d = 20 lb). Add them to the platform all at the same time. The indicator should indicate a weight value of 4d (80 lb, if d = 20 lb). If the 4 d is rezeroed, the device is in violation of S.2.1.3.

> ***S.2.1.3.1. Automatic Zero-Setting Mechanism on Class III L Devices -*** *Class III L devices equipped with automatic zero setting mechanisms shall be designed with a sealable means to allow the automatic zero setting to be disabled during the inspection and test of the device.*
> *[Nonretroactive as of January 1, 2001*] (Added 1999)

Handbook 44 Scales Code, Paragraph S.2.1.3.1.

Devices equipped with AZSM and manufactured on or after January 1, 2001 must be designed so that the AZSM may be disabled during the inspection and test. In addition, the AZSM must provide some means for applying a security seal.

Test of Tare Auto-Clear *(Electronic Indicating Only)*

On a device designed to clear any tare value automatically, the tare must not clear until a complete transaction has been indicated.

> ***S.2.3. Tare.*** *— On any scale (except a monorail scale equipped with digital indications), the value of*

*the tare division shall be equal to the value of the scale division.** The tare mechanism shall operate only in a backward direction (that is, in a direction of underregistration) with respect to the zero-load balance condition of the scale. *A device designed to automatically clear any tare value shall also be designed to prevent the automatic clearing of tare until a complete transaction has been indicated.** *(Amended 1985)*

*[Note: On a computing scale, this requires the input of a unit price, the display of the unit price, and a computed positive total price at a readable equilibrium. Other devices require a complete weighing operation, including tare, net, and gross weight determination.]**

*[*Nonretroactive as of January 1, 1983.]*

Handbook 44 Scales Code, Paragraph S.2.3.

On a computing scale, enter a tare weight and apply a load without computing a price. After the load is removed, the tare value must be retained in memory.

Test of Semi-Automatic Zero-Setting Mechanism *(Automatic-Indicating Only)*

If the indicator has a semi-automatic zero-setting mechanism (push button) that is not enclosed in a cabinet or accessible or operable only by a tool, the mechanism must not function unless the scale indication is stable within 3 scale divisions when the zero-setting button is pressed. If it does, the operator could intentionally or unintentionally subtract weight from the total load by hitting the button as a truck was being driven on the scale.

S.2.1.2. Scales Used in Direct Sales. — A manual zero-setting mechanism (except on a digital scale with an analog zero-adjustment mechanism with a range of not greater than one scale division) shall be operable or accessible only by a tool outside of and entirely separate from this mechanism, or it shall be enclosed in a cabinet. Except on Class I or II scales, a balance ball shall either meet this requirement or not itself be rotatable.

A semi-automatic zero-setting mechanism shall be operable or accessible only by a tool outside of and separate from this mechanism or it shall be enclosed in a cabinet, or it shall be operable only when the indication is stable within:

(a) Plus or minus 3 scale divisions for scales of more than 2,000 kg (5,000 lb) capacity in service prior to January 1, 1981, and for all axle-load, railway track, and vehicle scales.

Handbook 44 Scales Code, Paragraph S.2.1.2.

Test the functioning of the motion detection mechanism as follows:

- Apply a load to the scale in a manner that simulates actual use (for example, have someone drive a truck onto the scale).

- While the load is being applied (and the indicator is in motion by more than 3 d), push the zero-setting button. The scale should not rezero until oscillations have damped to 3 d or less.

If the device has a semi-automatic zero-setting mechanism (push button) it must comply with the motion detection requirement. A motion detection capability is not required on a device with power-switch “zero,” providing it has a “countdown” or checking feature when the power switch is activated.

Test of Printer connected to Electronic Indicating Element

As explained in Chapter 3, electronic devices equipped with printers must have an automatic means to prevent the printing of weight values unless the indication is stable within plus or minus 3 scale divisions. To check compliance with this requirement, you can use the procedure described above for testing the semi-automatic zero-setting mechanism; except that, when the indicator is in motion by more than 3 d, press the print button and check that the printer will not print a value until oscillations have damped to 3 d or less.

Over-Capacity Test *(If practical)*

Electronic digital indicating scales are required to have an indicating or recording element that will not display or record any values when the gross load on the deck is in excess of 105 percent of the capacity of the scale system. This will often be found to be an impractical test to conduct on vehicle and axle-load scales.

However, when it is practical, the scale should be loaded to a value greater than 105 percent of the system capacity. At that value, the system should not display or record any value. Paragraph S.1.7 of the Scales Code, which includes this requirement, was discussed in Chapter 3.

If there are unit weights in effect or in place at any time, they must automatically be accounted for on the indicated or recorded values. A display that indicates less than 105 percent of the capacity of the scale but still displays or records values when, in fact, the load on the scale is in excess of 105 percent of its capacity is not acceptable.

Zero-load Balance Change

The Test Notes portion of the EPOs instructs you to check the zero-load balance each time a test load is removed from the scale. You will have recorded any weight required to rebalance the scale (this is most easily determined if the error weight testing method is used). In accordance with N.1.9., the zero-load balance should not change by more than the minimum applicable tolerance. For maintenance tests, of vehicle and axle-load scales, this is 1 d; for acceptance tests, 0.5 d.

> **N.1.9. Zero-Load Balance Change.** — A zero-load balance change test shall be conducted on all scales after the removal of any test load. The zero-load balance should not change by more than the minimum tolerance applicable. (Also see G-UR.4.2.)

Handbook 44 Scales Code, Paragraph N.1.9.

After the last test load has been removed and the final zero-load balance checked, you should remove all error weights from the deck and rezero the scale so that it will be in the correct condition for normal operation.

Counterpoise Weights Test

If a scale employs removable counterpoise weights to balance the scale load, these weights must be tested to determine their compliance with the specifications and tolerances set forth in the Weights Code of Handbook 44. These procedures are not covered in this Course.

Summary

After you complete the Inspection of a vehicle or axle-load scale, and have constructed a tolerance worksheet for the scale (or determined applicable tolerances in some other manner), and after reviewing the Test Notes in the EPO, you are ready to test the device.

For weighbeam scales, the Test begins with determination of Sensitivity (SR) at Zero-Load. Next the Increasing-Load Test and Shift Test are performed. If maximum capacity of the scale has not been reached, a Strain-Load Test is conducted. Before weights are removed from the scale, SR at Maximum Load is tested. Whenever test weights are removed, Zero-Load Balance Change is checked. Finally, error weights are removed and a correct zero-balance condition is established.

For dial scales, the Increasing-Load Test and Shift Test are performed. Test loads are applied at each quarter of dial capacity, at each unit weight, at one-half and full CLC or section capacity, and at full available test load. A Decreasing-Load Test is performed for all automatic-indicating devices, including balance indicators that have definite values. If scale capacity was not reached during the Increasing-Load Test, a Strain-Load Test is conducted. Whenever test weights are removed, Zero-Load Balance Change is checked.

In a test of a scale with an electronic digital indicator, the Increasing-Load Test and Shift Test are performed, followed by the Decreasing-Load Test. A Strain-Load Test is conducted if necessary. Zero-Load Balance Change is rechecked whenever weights are removed. The device must be tested for proper design and function of any Tare Auto-Clear, Automatic Zero-Setting Mechanism, Semi-Automatic Zero-Setting Mechanism, or Printer Interfaced with an Electronic Indicating Element and for susceptibility to RFI/EMI, if a problem is suspected. After all tests are complete, a correct zero-load balance is established.

In addition, a Discrimination Test may be performed on automatic-indicating scales if deemed necessary and if environmental factors can be controlled.

If the scale has two systems of indicating and recording weights (dial and electronic indicating element, or type registering beam and electronic indicating element), then each system must be tested separately and reports prepared for each element. If the indicating and recording means are employed in combination, however, indications must agree to within specified tolerances.

Repeatability is checked whenever a test is repeated under the same conditions.