

2015 NIST EPO No. 12

Examination Procedure Outline for

Part 1 – Livestock and Animal Scales – Electronic Digital Indicating

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It is recommended that this outline be followed as minimum criteria for examining livestock and animal scales equipped with electronic digital indicators. See Part 2 for livestock and animal scales equipped with weighbeams or dials.

Requirements that apply only to scales marked with an accuracy class are indicated with an asterisk. Nonretroactive requirements are followed by the applicable date in parentheses.

SAFETY NOTES

When excerpting this Examination Procedure Outline for duplication, the EPO Safety Annex (Safety Considerations and Glossary of Safety Key Phrases) should be duplicated and included with this outline.

Safety policies and regulations vary among jurisdictions. It is essential that inspectors or servicepersons be aware of all safety regulations and policies in place at the inspection site and practice their employer's safety policies. The safety reminders included in this EPO contain general guidelines useful in alerting inspectors and servicepersons to the importance of taking adequate precautions to avoid personal injury. These guidelines can only be effective in improving safety when coupled with training in hazard recognition and control.

Prior to beginning any inspection, the inspector should read and be familiar with the EPO Safety Annex - "Safety Considerations and Glossary of Safety Key Phrases." The terms and key phrases in each safety reminder of this outline are found in the glossary of the EPO Safety Annex. The inspector is reminded of the importance of evaluating potential safety hazards prior to an inspection and taking adequate precautions to avoid personal injury or damage to the device. As a minimum, the following safety precautions should be noted and followed during the inspection.

Clothing

Personal Protection Equipment
e.g., Safety Shoes

Electrical Hazards

Safety Cones/Warning Signs

First Aid Kit

Support – for scales and test weights

Location

Transportation of Equipment

Lifting

Also:

Wet/Slick Conditions

Overhead Hazard, Materials, or Obstructions

**H-44 General Code and
Scale Code References**

Inspection:

SAFETY REMINDER!!!

- **Check the inspection site carefully for safety hazards and take appropriate precautions.**
- **Use caution while moving in wet, slippery areas.**
- **Use personal protection equipment appropriate for the inspection site.**
- **Be sure that a first aid kit is available and that the kit is appropriate for the type of inspection activity.**
- **Be sure that a first aid kit is available and that the kit is appropriate for the type of inspection activity.**

1. Zero-load balance as found. If the device is not in balance, the user should be made aware of paragraph UR.4.1. and a warning issued if necessary. If at a ring scale and a tare has been taken for a ring man, check accuracy of the tare taken..... S.1.1., S.2.1.1., S.2.1.2., UR.4.1., G-S.5.2.2.(d) (1/1/86)*
2. General Considerations
 - Selection G.S.3., G-UR.1.1, UR.1.
 - Installation G-UR.2.
 - Supports for portable scale UR.2.1.
 - Protection from environment UR.2.3.
 - Foundation, supports, and clearance UR.2.4.
 - Access to weighing elements UR.2.5.
 - Stock racks UR.2.7.

SAFETY REMINDER!!!

- **Check to be sure the scale supports are adequate to support the scale and test loads equal to the capacity of the scale!**

- Maintenance, use, and environmental factors.
- Facilitation of fraud G-S.2.
 - Environment G-UR.1.2.
 - Operation G-UR.3.1.
 - Maintenance G-UR.4.
 - Maximum load UR.3.2.
 - Minimum load for livestock UR.3.8.
 - Manual gross weights UR.3.9., S.1.12.
 - Scale modification UR.4.3
 - Accessibility for inspection, testing, and sealing G-UR.2.3.
 - Assistance G-UR.4.4.
 - Position, customer readability G-UR.3.3.

H-44 General Code and Scale Code References

Inspection (cont.):

3. Marking	S.6.3., S.6.2., S.6.5., G-S.1.1.
a. Marking requirements - all devices	
Identification.	G-S.1.
Name, initials or trademark of manufacturer or distributor.	Retroactive
Model identifier designation.	Retroactive
Model prefix.	(1/1/03)
Nonrepetitive serial number.	(1/1/68)
Serial number prefix.	(1/1/86)
Software version or revision number.	(1/1/04)
NTEP CC prefix and number (for devices that have an NTEP CC).	(1/1/03)
Remanufacturer information, as appropriate:	
name and ID of remanufacturer or distributor.	(1/1/02)
model number if different from original model number.	(1/1/02)
Lettering.	G-S.7.
Operational controls, indications, and features.	G-S.6. (1/1/77)
Visibility of identification.	G-UR.2.1.1.
Interchange or reversal of parts.	G-S.4.
b. Marking requirements - weighing and indicating elements in same housing or covered on the same CC (in addition to marking for all devices).	S.6.3.
Accuracy class.	(1/1/86)
Nominal capacity.	Retroactive
Value of scale division with nominal capacity, if not apparent.	(1/1/83)
Value of "e" (if different from "d").	(1/1/86)
Temperature limits if narrower than and within – 10 °C to 40 °C (14 °F to 104 °F)	(1/1/86)
Scales designed for special application.	(1/1/86)
c. Marking requirements - indicating element not permanently attached or covered on separate CC (in addition to marking for all device).	S.6.3.
Accuracy class.	(1/1/86)
Nominal capacity.	Retroactive
Value of scale division with nominal capacity, if not apparent.	(1/1/83)
Value of "e" (if different from "d")	(1/1/86)
Temperature limits if narrower than and within – 10 °C to 40 °C (14 °F to 104 °F)	(1/1/86)
Scales designed for special application.	(1/1/86)
Maximum number of scale divisions (n_{max}).	(1/1/88)
Concentrated Load Capacity (CLC) or Section Capacity.	S.6.5. (1/1/03) Table S.6.3.(a)(b)
d. Marking requirements - weighing and load-receiving element not permanently attached or covered on separate CC (in addition to marking for all devices).	S.6.3.
Accuracy class.	(1/1/86)
Nominal capacity.	Retroactive
Nominal capacity on load-receiving element.	(1/1/89) (livestock only)
Concentrated Load Capacity (CLC) or Section Capacity.	S.6.5. (1/1/03) Table S.6.3.(a)(b)

**H-44 General Code and
 Scale Code References**

Inspection (cont.):

Marking (cont.)

Temperature limits if narrower than and within –10 °C to 40 °C (14 °F to 104 °F)	(1/1/86)
Scales designed for special application.....	(1/1/86)
Maximum number of scale divisions (n_{max}).....	(1/1/88)
Minimum verification scale division for which device complies with the requirements (e_{min} or d)	(1/1/88)

- e. Marking requirements - load cell with Certificate of Conformance (in addition to marking for all devices)..... S.6.3., S.5.4. (1/1/94)

Note: Requires information on a data plate attached to the load cell or in accompanying document. If a document is provided, the serial number shall appear on the load cell and in the document..... S.6.3., (1/1/88)

Manufacturer’s name or trademark, model designation, model prefix and serial number and prefix shall also be marked on both the load cell and in any accompanying documents.	(1/1/91)
Accuracy class.....	(1/1/88)
Temperature limits if narrower than and within – 10 °C to 40 °C (14 °F to 104 °F) ...	(1/1/86)
Maximum number of divisions.....	(1/1/88)
“S” or “M” for single or multiple cell applications.	(1/1/88)
Direction of loading, if not obvious.....	(1/1/88)
Minimum dead load, maximum capacity, safe load limit, and load cell verification interval, V_{min}	(1/1/88)

4. Determination of Load Cell Suitability (applicable to load cells with an NTEP Certificate of Conformance):

- a. The number of scale divisions (n) of the scale is less than or equal to the n_{max} of the indicator or the load cells, whichever is less; for example, if the indicator has an n_{max} of 10 000 and the load cells have an n_{max} of 5000, then the scale may use up to 5000 divisions.
- b. The load cell is approved for the required accuracy class. **Note:** A Class III load cell may be used in a Class III L application; however, the opposite is not true.
- c. The load cell is rated Single (S) or Multiple (M) use as appropriate to the application. **Note:** A load cell rated for single use may be used in a single or multiple load cell application; however, a load cell rated for multiple uses cannot be used in a single load cell application.
- d. The load cell complies with the requirements for temperature effect on zero-load balance..... S.5.4. (1/1/94), T.N.8.1
 Appendix to EPO 12-E

H-44 General Code and Scale Code References

Inspection (cont):

Marking (cont.)

Note: Testing to determine the effect of temperature on zero-load balance cannot be performed in the field; however, for purposes of field inspection, a load cell is considered to comply with T.N.8.1.3. if the V_{min} value marked on the load cell is less than or equal to the V_{min} value as calculated below based upon the d and N for the scale; if it is not, the scale does not comply with T.N.8.1.3.

Full electronic scale with more than one load cell: The verification scale division V_{min} , for the load cells must be less than or equal to the scale division, d , divided by the square root of the number of load cells, N , used in the scale:

$$v_{min} \leq \frac{d^*}{\sqrt{N}}$$

Note: Maximum values of v_{min} for commonly encountered multiple load cell scales are listed in the Appendix to EPO 12-E.

For scales with mechanical lever systems:

$$v_{min} \leq \frac{d^*}{\sqrt{N} \times (\text{scale multiple})}$$

**When the value of the scale division, d , is different from the verification scale division, e , for the scale, the value of e must be used in the formulae above.*

5. Indicating and Recording Elements

Value of scale division.	S.1.2.* (1/1/86)
Weight units.	S.1.2.1. (1/1/89)
Designation of accuracy class.....	S.5.*
Value of graduated interval.	G-S.5.3.
Marked devices.....	UR.1.1.(a)
Unmarked devices.	UR.1.1.(b)(animal only)
Recording elements, General.....	G-S.5.6.
Recorded scale division.	UR.1.3. (1/1/86)
Tare division value, if equipped with a keyboard ¹	S.2.3.(1/1/83)
Tare mechanism	S.2.3.(1/1/83)
Appropriateness.	
Indicating and recording elements.	G-S.5.
Parameters for Accuracy Class.	S.5.2.(1/1/86)
Selection.....	UR.1.
Initial zero-setting mechanism.	S.2.1.5.
Recommended minimum load.	UR.3.1.
Minimum load for weighing livestock	UR.3.8.

¹ Generally, tare is not considered appropriate on these scales. If the device is located in an auction market and is a ring scale, a tare capability may be considered appropriate.

H-44 General Code and Scale Code References

Inspection (cont):

Marking (cont.)

Maximum load.....	UR.3.2.
Manual gross weight entries.....	S.1.12.(1/1/05), G-S.8. (1/1/90), UR.3.9.(e)
Damping means.....	S.2.5., S.2.5.1.
Adjustable components.....	S.1.10.
Provisions for sealing.....	G-UR.4.5. S.1.11., (1/1/93)
 6. Design of weighing elements.....	 S.4.

Pretest Determinations:

1. Tolerances.	
Acceptance/maintenance.....	G-T.1., G-T.2.
Application.....	G-T.3., G-T.4., T.N.2.1., T.N.2.3.

Tolerance values:

Determine number of scale divisions (n) e division if scale is marked with an accuracy designation.

$$n = \frac{\text{scale capacity}}{\text{value of scale division}}$$

Maintenance tolerance.....	T.N.3.1./Table 6 (Class III L - Livestock) (Class III - Animal)
Acceptance tolerance.....	T.N.3.2.
Agreement of indications.....	T.N.4.
Repeatability.....	T.N.5.
Unmarked scales.....	T.1.1.
Discrimination.....	T.N.7.1.*
Substitution or Strain Tests (if necessary).....	T.N.3.11., T.N.3.12.
 2. Determine “used capacity.”	
For calculation in metric units:	
Multiply area of platform in square meters (length x width = area) by:	
540 kg for cattle, 340 kg for calves and hogs, and 240 kg for sheep.	
For calculation in U.S. customary units:	
Multiply area of platform in square feet (length x width = area) by: 110 lb	
for cattle, 70 lb for calves and hogs, and 50 lb for sheep.	
 3. Minimum test weights and test loads.....	 N.3./Table4

Pretest Determinations (cont.)

SAFETY REMINDER

- Carefully inspect electrical supply lines for test equipment for wear or damage; correct potentially hazardous conditions before use; protect lines from damage during use.

Test Notes:

SAFETY REMINDER

- Wear appropriate personal protection equipment such as safety shoes to prevent possible injury from falling weights and slipping on slick surfaces and a hard hat to prevent injury from overhead hazards.

1. Check repeatability of, and agreement between, indications throughout test..... G-S.5.2.2.(b), T.N.5.
2. Recheck zero-load balance each time test load is removed..... N.1.9., G-UR.4.2.
3. If the scale is equipped with printer, print ticket at each test load..... G-S.5.6., UR.1.3.
(1/1/86)

Also verify that any options for obtaining a recorded representation are appropriate. The customer may be given the option of not receiving the recorded representation. If the system is equipped with the capability, the customer may also be given the option of receiving the recorded representation electronically in lieu of or in addition to a hard copy. G-S.5.6.

Test:

SAFETY REMINDER

- **WEAR SAFETY SHOES!**
- **USE PROPER LIFTING TECHNIQUES!**

1. Discrimination test at zero load (dials and balance indicators only). N.1.5.(1/1/86)
2. Increasing-load test.
Test to used capacity with the test load distributed. N.1.1.

H-44 General Code and Scale Code References

Test (cont.):

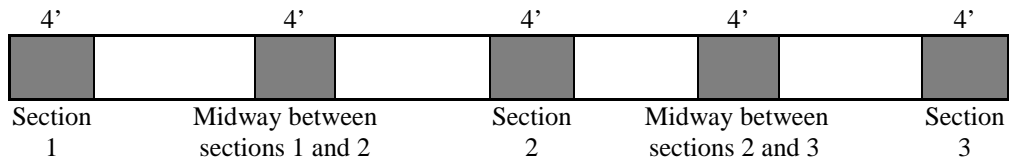
- 3. Shift test. (May be conducted during increasing-load test).
Vehicle Scales, Axle-Load Scales, and Livestock Scales..... N.1.3.3.

Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales..... N.1.3.3.1.

Minimum Shift Test. At least one shift test shall be conducted with a minimum test load of 12.5 % of scale capacity, which 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.1.3.3.2. Prescribed Test Pattern and Test Loads for Livestock Scales with More Than Two Sections and Combination Vehicle/Livestock Scales.)

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. An example of a possible test pattern is shown in the following diagram.



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.

- To test to the nominal capacity, multiple patterns may be simultaneously loaded in a manner consistent with the method of use. N.1.3.3.2.

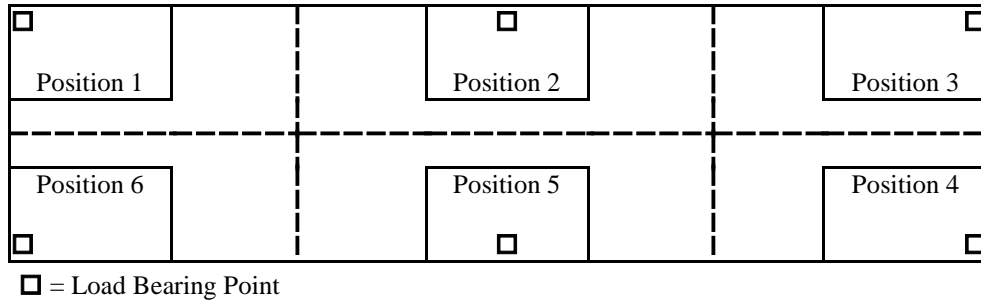
Special design scales and those that are wider than 3.7 m (12 ft) shall be tested in a manner consistent with the method of use but following the principles described above.

Prescribed Test Pattern and Test Loads for Livestock Scales with More Than Two Sections and Combination Vehicle/Livestock Scales..... N.1.3.3.1.

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.

H-44 General Code and Scale Code References

Test (cont.)

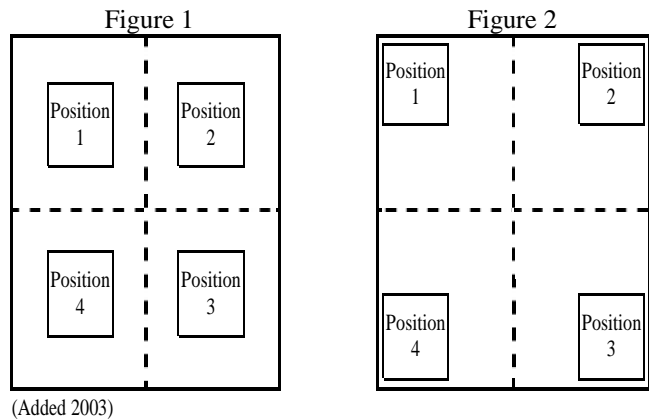


Two-section livestock scales. N.1.3.3.3., N.1.3.7.

A shift test shall be conducted using the following prescribed test loads and test patterns, provided the shift test load does not exceed one-half the rated section capacity or one-half the rated concentrated load capacity whichever is applicable, using either:

A one-half nominal capacity test load centered as nearly as possible, successively at the center of each quarter of the load-receiving element as shown in N.1.3.7. All Other Scales Except Crane Scales, Hanging Scales, Hopper Scales, Wheel-Load Weighers, and Portable Axle-Load Weighers Figure 1 (below); or

A one-quarter nominal capacity test load centered as nearly as possible, successively over each main load support as shown in N.1.3.7. All Other Scales Except Crane Scales, Hanging Scales, Hopper Scales, Wheel-Load Weighers, and Portable Axle-Load Weighers Figure 2 as shown in the following diagram:



**H-44 General Code and
 Scale Code References**

Test (cont.)

Animal Scales..... N.1.3.7.

For scales with a nominal capacity of 500 kg (1000 lb) or less, a shift test shall be conducted using a one-third nominal capacity test load (defined as test weights in amounts of at least 30 % of scale capacity, but not to exceed 35 % of scale capacity) centered as nearly as possible at the center of each quadrant of the load-receiving element using the prescribed test pattern as shown in Figure 1 (as shown above under Two-section livestock scales).

For scales with a nominal capacity greater than 500 kg (1000 lb), a shift test may be conducted by either using a one-third nominal capacity test load (defined as test weights in amounts of at least 30 % of scale capacity, but not to exceed 35 % of scale capacity) centered as nearly as possible at the center of each quadrant of the load-receiving element using the prescribed test pattern as shown in Figure 1, or by using a one-quarter nominal capacity test load centered as nearly as possible, successively, over each corner of the load-receiving element using the prescribed test pattern as shown in Figure 2 (as shown above under Two-section livestock scales).

- 4. Time Dependence Test..... T.N.4.5.Class III
 (Animal Scales)
 T.N.4.5.1.Class III L
 (Livestock scales)
- 5. Discrimination test at maximum test load. T.N.4.5.2.
- 6. Decreasing-load test at one-half of maximum test load..... N.1.5.
- 7. Remove all test weights and determine any zero-load balance change. N.1.2.
- 8. Remove error weights and establish correct zero-load balance..... N.1.9., G-UR.4.2.

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Examination Procedure Outline for

Livestock and Animal Scales

Part 2 – Mechanical/Analog Indicating

It is recommended that this outline be followed for livestock and animal scales equipped with weighbeams or dials. Requirements that apply only to scales marked with an accuracy class are indicated with an asterisk. Nonretroactive requirements are followed by the applicable date in parentheses.

Safety Notes: See EPO 12, Part 1

**H-44 General Code and
Scale Code References**

Inspection:

SAFETY REMINDER!!!

- Check the inspection site carefully for safety hazards and take appropriate precautions.
- Use caution while moving in wet, slippery areas.
- Use personal protection equipment appropriate for the inspection site.
- Be sure that a first aid kit is available and that the kit is appropriate for the type of inspection activity.
- Be sure that a first aid kit is available and that the kit is appropriate for the type of inspection activity.

- | | |
|---|--|
| 1. Zero-load balance as found..... | S.1.1., S.2.1.1., S.2.1.2.,
S.1.5.1., S.2.2., UR.4.1. |
| 2. General Considerations | |
| Selection | G.S.3., G-UR.1.1, UR.1. |
| Installation | G-UR.2. |
| Supports for portable scale | UR.2.1. |
| Protection from environment..... | UR.2.3. |
| Foundation, supports, and clearance | UR.2.4. |
| Access to weighing elements. | UR.2.5. |
| Stock racks | UR.2.7. |

SAFETY REMINDER!!!

- Check to be sure the scale supports are adequate to support the scale and test loads equal to the capacity of the scale!

**H-44 General Code and
Scale Code References**

Inspection (cont.):

Maintenance, use, and environmental factors.	
Facilitation of fraud.....	G-S.2.
Environment.....	G-UR.1.2.
Operation.....	G-UR.3.1.
Maintenance.....	G-UR.4.
Maximum load.....	UR.3.2.
Minimum load for livestock.....	UR.3.8.
Scale modification.....	UR.4.3
Accessibility for inspection, testing, and sealing.....	G-UR.2.3.
Assistance.....	G-UR.4.4.
Position, customer readability.....	G-UR.3.3.
 3. Marking.....	 S.6.3., S.6.2., S.6.5., G-S.1.1.
a. Marking requirements - all devices	
Identification.....	G-S.1.
Name, initials, or trademark of manufacturer or distributor.....	Retroactive
Model identifier designation.....	Retroactive
Model prefix.....	(1/1/03)
Nonrepetitive serial number.....	(1/1/68)
Serial number prefix.....	(1/1/86)
NTEP CC prefix and number (for devices that have an NTEP CC).....	(1/1/03)
Remanufacturer information, as appropriate:	
name and ID of remanufacturer or distributor.....	(1/1/02)
model number if different from original model number.....	(1/1/02)
Lettering.....	G-S.7.
Operational controls, indications, and features.....	G-S.6. (1/1/77)
Visibility of identification.....	G-UR.2.1.1.
Interchange or reversal of parts.....	G-S.4.
b. Marking requirements - weighing and indicating elements in same housing or covered on the same CC (in addition to marking for all devices).....	S.6.3.
Accuracy class.....	(1/1/86)
Nominal capacity.....	(1/1/83)
Value of scale division with nominal capacity, if not apparent.....	(1/1/86)
Value of "e" (if different from "d").....	(1/1/86)
Temperature limits if narrower than and within – 10 °C to 40 °C (14 °F to 104 °F).....	(1/1/86)
Scales designed for special application.....	Retroactive
c. Marking requirements - indicating element not permanently attached or covered on separate CC (in addition to marking for all device).....	S.6.3.
Accuracy class.....	(1/1/86)
Nominal capacity.....	Retroactive
Value of scale division with nominal capacity, if not apparent.....	(1/1/83)
Value of "e" (if different from "d").....	(1/1/86)
Temperature limits if narrower than and within –10 °C to 40 °C (14 °F to 104 °F).....	(1/1/86)

H-44 General Code and Scale Code References

Inspection (cont.):

Scales designed for special application.....	(1/1/86)
Maximum number of scale divisions (n_{max}).....	(1/1/88)
Concentrated Load Capacity (CLC) or Section Capacity.	S.6.5. (1/1/03) Table S.6.3.(a)(b)
d. Marking requirements - weighing and load-receiving element not permanently attached or covered on separate CC (in addition to marking for all devices).....	
Accuracy class.	S.6.3. (1/1/86)
Nominal capacity.	Retroactive
Nominal capacity on load-receiving element.....	(1/1/89) (livestock only)
Concentrated Load Capacity (CLC) or Section Capacity.	S.6.5. (1/1/03)
Temperature limits if narrower than and within $-10\text{ }^{\circ}\text{C}$ to $40\text{ }^{\circ}\text{C}$ ($14\text{ }^{\circ}\text{F}$ to $104\text{ }^{\circ}\text{F}$).	Table S.6.3.(a)(b)
Scales designed for special application.....	(1/1/86)
Maximum number of scale divisions (n_{max}).	(1/1/86)
Minimum verification scale division for which device complies with the requirements (e_{min} or d)	(1/1/88)
4. Indicating and Recording Elements	
Value of Scale Division.	S.1.2.* (1/1/86)
Designation of accuracy class.	S.5.*, UR.1.1.
Weighbeams.....	S.1.5. except S.1.5.5.
Poises.	S.1.6.
Dials and balance indicators. ¹	S.1.3., S.1.4.
Damping means.	S.2.5.
Appropriateness.	
Indicating and recording elements.	G.S.5. except G-S.5.2.2.
Parameters for Accuracy Class.	S.5.2.(1/1/86)*
Selection.	UR.1.1.
Suitability.....	G-UR.1.1.
Recommended minimum load.	UR.3.8
Maximum load.	UR.3.2.
Adjustable components.....	S.1.10.
5. Design of weighing elements.	
	S.4.

Pretest Determinations:

1. Tolerances.	
Acceptance/maintenance.....	G-T.1., G-T.2.
Application.....	G-T.3., G-T.4., T.N.2.1., T.N.2.3.
Ratio tests.....	T.N.2.5.

¹ A balance indicator with graduations having specific values shall be considered a dial.

H-44 General Code and Scale Code References

Pretest Determinations (cont.):

Tolerance values:

Determine number of scale divisions (n) e division if scale is marked with an accuracy designation.

$$n = \frac{\text{scale capacity}}{\text{value of scale division}}$$

Maintenance tolerance.....	N.3.1./Table 6 (Class III L - Livestock) (Class III - Animal)
Acceptance tolerance.....	T.N.3.2.
Agreement of indications.....	T.N.4.
Repeatability.....	T.N.5.
Unmarked scales.....	T.1.1.
Repeatability.....	T.N.5.
Discrimination.....	T.N.7.1.*
 Sensitivity:	
Marked scales.....	T.N.6.1.(a), T.N.6.2.
Unmarked scales.....	T.2.1.,T.2.7., T.3.(a) or (c)
Substitution or Strain Tests (if necessary).....	T.N.3.11., T.N.3.12.

2. Determine “used capacity.”

For calculation in metric units:

Multiply area of platform in square meters (length x width = area) by: 540 kg for cattle, 340 kg for calves and hogs, and 240 kg for sheep.

For calculation in inch pound units:

Multiply area of platform in square feet (length × width = area) by: 110 lb for cattle, 70 lb for calves and hogs, and 50 lb for sheep.

3. Minimum test weights and test loads. N.3./Table 4

SAFETY REMINDER!!!

– **Carefully inspect electrical supply lines for test equipment for wear or damage; correct potentially hazardous conditions before use; protect lines from damage during use.**

H-44 General Code and Scale Code References

Test Notes:

SAFETY REMINDER!!!

- **Wear appropriate personal protection equipment such as safety shoes to prevent possible injury from falling weights and slipping on slick surfaces and a hard hat to prevent injury from overhead hazards.**

1. For beam scales, balance small error weights on platform, the smallest weight equal to the minimum tolerance applicable, and the total value of the weights equal to the tolerance at maximum test load.
2. Check repeatability of, and agreement between, indications throughout test..... G-S.5.2.2.(b), T.N.5.
3. Recheck zero-load balance each time test load is removed..... N.1.9., G-UR.4.2.
4. If the scale is equipped with a type-registering (TR) beam or printer, print ticket at each test load. G-S.5.6., UR.1.3.(1/1/86)

Test:

SAFETY REMINDER!!!

- **WEAR SAFETY SHOES!**
- **USE PROPER LIFTING TECHNIQUES!**

1. Sensitivity test at zero load (for weighbeams only)..... N.1.4.
Discrimination test at zero load (dials and balance indicators only). N.1.5.(1/1/86)
2. Increasing-load test.
Test to used capacity with the test load distributed. N.1.1.
 - a. For beam scales, the minimum test includes testing at half and full capacity on fractional beam, 100 lb increments to 1000 lb, and three other points on main weighbeam, including used capacity.

Scales not equipped with a full capacity beam should be ratio tested using standard weights on counterpoise hanger. At each test load, test scale counterpoise weights by substituting them for standard counterpoise weights. If there is any noticeable change in the indication, remove the scale weight from service until it can be determined that it meets requirements in the Weight Code of NIST Handbook 44.

Ratio Test N.1.7.

Test (cont.)

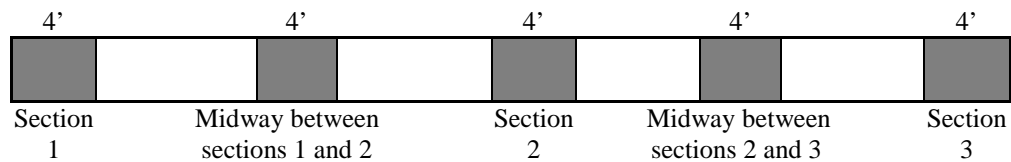
When ratio testing, test poise and beam by the removal of standard weights from the counterpoise hanger

- b. Dial scales. Test at 100 lb increments to 1000 lb and at each quarter of dial capacity. Test all unit or drop weights normally used.
3. Shift test. (May be conducted during increasing-load test).
- Vehicle Scales, Axle-Load Scales, and Livestock Scales..... N.1.3.3.
 - Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales. N.1.3.3.1.

Minimum Shift Test. At least one shift test shall be conducted with a minimum test load of 12.5 % of scale capacity, which 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.1.3.3.2. Prescribed Test Pattern and Test Loads for Livestock Scales with More Than Two Sections and Combination Vehicle/Livestock Scales.

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. An example of a possible test pattern is shown in the following diagram.



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.

To test to the nominal capacity, multiple patterns may be simultaneously loaded in a manner consistent with the method of use. N.1.3.3.2.

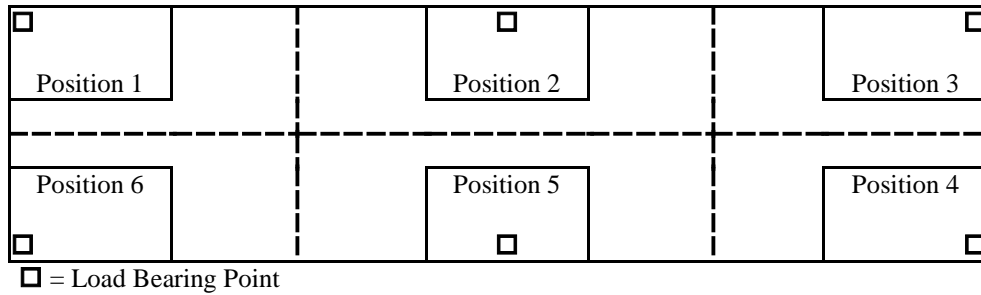
Special design scales and those that are wider than 3.7 m (12 ft) shall be tested in a manner consistent with the method of use but following the principles described above.

Prescribed Test Pattern and Test Loads for Livestock Scales with More Than Two Sections and Combination Vehicle/Livestock Scales..... N.1.3.3.1.

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Test (cont.)

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.

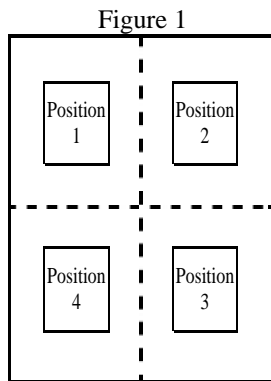


Two-section livestock scales. N.1.3.3.3., N.1.3.7.

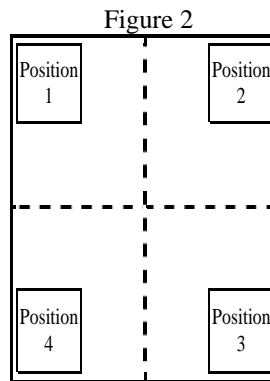
A shift test shall be conducted using the following prescribed test loads and test patterns, provided the shift test load does not exceed one-half the rated section capacity or one-half the rated concentrated load capacity whichever is applicable, using either:

A one-half nominal capacity test load centered as nearly as possible, successively at the center of each quarter of the load-receiving element as shown in N.1.3.7. All Other Scales Except Crane Scales, Hanging Scales, Hopper Scales, Wheel-Load Weighers, and Portable Axle-Load Weighers Figure 1 (below); or

A one-quarter nominal capacity test load centered as nearly as possible, successively over each main load support as shown in N.1.3.7. All Other Scales Except Crane Scales, Hanging Scales, Hopper Scales, Wheel-Load Weighers, and Portable Axle-Load Weighers Figure 2 as follows:



(Added 2003)



**H-44 General Code and
Scale Code References**

Tests (cont.)

Animal Scales..... N.1.3.7.

For scales with a nominal capacity of 500 kg (1000 lb) or less, a shift test shall be conducted using a one-third nominal capacity test load (defined as test weights in amounts of at least 30 % of scale capacity, but not to exceed 35 % of scale capacity) centered as nearly as possible at the center of each quadrant of the load-receiving element using the prescribed test pattern as shown in Figure 1 (as shown above under Two-section livestock scales).

For scales with a nominal capacity greater than 500 kg (1000 lb), a shift test may be conducted by either using a one-third nominal capacity test load (defined as test weights in amounts of at least 30 % of scale capacity, but not to exceed 35 % of scale capacity) centered as nearly as possible at the center of each quadrant of the load-receiving element using the prescribed test pattern as shown in Figure 1, or by using a one-quarter nominal capacity test load centered as nearly as possible, successively, over each corner of the load-receiving element using the prescribed test pattern as shown in Figure 2 (as shown above under Two-section livestock scales).

- 4. Time Dependence Test (Non-Automatic Weighing Instruments) T.N.4.5.Class III
 (Animal Scales)
 T.N.4.5.1.Class III L
 (Livestock scales)
 T.N.4.5.2.

- 5. Sensitivity test at maximum test load (weighbeams and balance indicators only) N.1.4.
 Discrimination test at maximum test load (dials and balance indicators only) N.1.5.

- 6. Decreasing-load test (dials only) at one-half of maximum test load (at no less than
 one-half dial face capacity) N.1.2.

- 7. Remove all test weights and determine any zero-load balance change. N.1.9., G-UR.4.2.

- 8. Remove error weights and establish correct zero-load balance.

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Examination Procedure Outline for

Vehicle and Axle-Load Scales Part 1 – Electronic Digital Indicating

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It is recommended that this outline be followed as minimum criteria for examining vehicle and axle-load scales (load-receiving elements) equipped with electronic digital indicators. Requirements that apply only to scales marked with an accuracy class are indicated with an asterisk. Non-retroactive requirements are followed by the applicable date in parentheses.

SAFETY NOTES

When excerpting this Examination Procedure Outline for duplication, the NIST EPO Safety Annex (Safety Considerations and Glossary of Safety Key Phrases) should be duplicated and included with this outline.

Safety policies and regulations vary among jurisdictions. It is essential that inspectors or servicepersons be aware of all safety regulations and policies in effect at the inspection site and to practice their employer's safety policies. The safety reminders included in this EPO contain general guidelines useful in alerting inspectors and servicepersons of the importance in taking adequate precautions to avoid personal injury. These guidelines can only be effective in improving safety when coupled with training in hazard recognition and control.

Prior to beginning any inspection, the inspector should read and be familiar with the NIST EPO Safety Annex - "Safety Considerations and Glossary of Safety Key Phrases." The terms and key phrases in each safety reminder of this outline are found in the glossary of the EPO Safety Annex. The inspector is reminded of the importance of evaluating potential safety hazards prior to an inspection and taking adequate precautions to avoid personal injury or damage to the device. As a minimum, the following safety precautions should be noted and followed during the inspection:

Clothing

Electrical Hazards

First Aid Kit

Lifting

Location

also: Wet/Slick Conditions

Chemicals, Petroleum Products, and Hazardous

Materials

Overhead Hazards

Obstructions

Personal Protection Equipment

e.g., Safety Shoes

**Hard Hat - for protection from
overhead hazards**

Safety Cones/Warning Signs

**Support - for scale, test weights,
and test equipment**

Transportation of Equipment

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H-44 General Code and Scales Code References

Inspection:

SAFETY REMINDER!!!

- Check the inspection site carefully for safety hazards and take appropriate precautions.
- Learn the nature of hazardous products used at or near the inspection site.
- Use personal protection equipment appropriate for the inspection site.
- Be sure that a first aid kit is available and that the kit is appropriate for the type of inspection activity

1. Position of equipment G-UR.3.3.

2. Zero-load balance as found. S.1.1., UR.4.1.
 If the device is not in balance, the user should be made aware of paragraph UR.4.1.
 and a warning issued if necessary.
 - Display of digital zero G-S.5.2.2.(d) (1/1/86)
 - Digital zero indication S.1.1.1.(a)
 - Center of zero indication S.1.1.1.(b) (1/1/93)
 - Zero-load adjustment..... S.2.1.1., S.2.1.2., S.2.1.3.

3. Indicating, and recording elements.
 - Appropriateness..... G-S.5.1.
 - Graduations, indications, and recorded representations G-S.5.2.
 - Values of graduated intervals or increments G-S.5.3., S.1.2.*, S.1.2.1.
 - Repeatability..... G-S.5.4.
 - Money values, mathematical agreement G-S.5.5.
 - Recorded representations, General G-S.5.6., UR.1.3. (1/1/86)
 - Magnified graduations and indications G-S.5.7.
 - Rounding (digital values) G-5.2.2.(c)
 - Manual Gross Weight Entries S.1.12.(1/1/93) (1/01/05),
UR.3.9.
 - Tare S.2.3.(1/1/83)
 - Damping and motion detection S.2.5., S.2.5.1.(a)

4. Design of weighing devices,
 - Accuracy class..... S.5.1.*, S.5.2.*
 - Multi-interval and multiple range scales, division value..... S.5.3.
 - Adjustable components/Sealing S.1.10., G-S.8.(1/1/90)
G-S.8.1.(1/1/10),
S.1.11.(a) (1/1/79),
S.1.11.(b) (1/1/90),
S.1.11.(c) (1/1/95)
 - Relationship of load cell v_{min} to scale division d S.5.4. (1/1/94)
 - Assistance..... G-UR.4.4.

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Inspection (cont.)

5. Suitability.....	G-UR.1.1., G-UR.1.2., UR.1., UR.1.1.(a), UR.1.1.(b), UR.3.1., UR.3.5., UR.3.7.
6. Marking.....	S.6., S.6.3., S.6.2.
Nominal capacity (Suitability).....	S.6.1. (1/1/89)
Nominal capacity must satisfy the relationship of: nominal capacity ≤ CLC x (N - 0.5), where N = the number of sections in the scale	
a. Marking requirements - all devices	
Identification.....	G-S.1.
Name or ID of manufacture	Retroactive
Model designation	Retroactive
Model prefix	(1/1/03)
Nonrepetitive serial number except not built-for-purpose devices	(1/1/68)
Serial number prefix	(1/1/86)
Serial number – appropriate abbreviations	(1/1/01)
Version or revision number - not built-for-purpose software-based devices	(1/1/04)
Version or revision number – appropriate abbreviations	(1/1/07)
NTEP CC prefix and number.....	(1/1/03)
(for devices that have an NTEP CC)	
Remanufacturer information, as appropriate:	
name and ID of remanufacturer	G-S.1.2. (1/1/02)
model number if different from original model number	G-S.1.2. (1/1/02)
Visibility of identification.....	G-UR.2.1.1.
Location of information - not built-for-purpose, software-based devices	G-S.1.1. (1/1/04)
Lettering.....	G-S.7.
Operational controls, indications, and features.....	G-S.6. (1/1/77)
Interchange or reversal of parts.....	G-S.4.
b. Marking requirements - indicating element not permanently attached or covered on separate CC (in addition to marking for all device)	S.6.3.
Accuracy class	(1/1/86)
Nominal capacity	Table S.6.3.b. footnote 18
Value of scale division with nominal capacity, if not apparent	(1/1/83)
Value of "e" (if different from "d").....	(1/1/86)
Temperature limits if other than -10 °C to 40 °C (14°F to 104 °F)	(1/1/86)
Concentrated load capacity (CLC).....	(1/1/89)
Section capacity (Sec Cap) ¹	Retroactive ¹

¹ Indicating and weighing/load-receiving elements manufactured prior to 1/1/89 are required to be marked with a section capacity rating. However, it is acceptable for these devices to be marked with a CLC instead. It is not permissible, however, to substitute a section rating for a CLC on devices manufactured or placed into service on or after 1/1/89.

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Inspection (cont.)

Combination vehicle (CLC)/railway scales (Sec Cap).....	(1/1/00)
Scales designed for special purposes	(1/1/86)
Maximum number of scale divisions (n_{max}).....	(1/1/88)

c. Marking requirements - weighing and load-receiving element not permanently attached or covered on separate CC (in addition to marking for all devices)..... S.6.3.

Accuracy class	(1/1/86)
Nominal capacity on load receiving element	(1/1/89)
Concentrated load capacity (CLC).....	(1/1/89)
Section capacity (see note below).....	Retroactive
Combination vehicle (CLC)/railway scales (Sec Cap)	(1/1/00)
Temperature limits if other than -10 °C to 40 °C (14 °F to 104 °F)	(1/1/86)
Scales designed for special purposes	(1/1/86)
Maximum number of scale divisions (n_{max}).....	(1/1/88)
Minimum verification scale division (e_{min} or d_{min}).....	(1/1/88)

Note: Indicating and weighing/load-receiving elements manufactured prior to 1/1/89 are required to be marked with a section capacity rating. However, it is acceptable for these devices to be marked with a CLC instead. It is not permissible, however, to substitute a section rating for a CLC on devices manufactured or placed into service on or after 1/1/89.

d. Marking requirements - load cell with Certificate of Conformance (in addition to marking for all devices)..... S.6.3., S.5.4. (1/1/94)

Accuracy class.....	(1/1/86)
Temperature limits if other than -10 °C to 40 °C (14 °F to 104 °F)	(1/1/86)
Maximum number of divisions (n_{max}).....	(1/1/88)
“S” or “M” for single or multiple cell applications.....	(1/1/88)
Direction of loading, if not obvious.....	(1/1/88)
Minimum dead load, maximum capacity, safe load limit, and load cell verification interval, v_{min}	(1/1/88)

Note: Requires information on a data plate attached to the load cell or in accompanying document. If a document is provided, the serial number shall appear on the load cell and in the document (1/1/88).

Note: Manufacturer’s name or trademark, model designation, model prefix and serial number and prefix shall also be marked on both the load cell and in any accompanying documents (1/1/91).

If possible, observe normal weight determinations that are equal to or greater than the weight of the test equipment and test weights to verify the adequacy of the scale supports!

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Inspection (cont.)

- 7. Design of weighing/load-receiving elements S.4. UR.2.8.
 Access..... UR.2.5
- 8. Load cell installation and suitability
 - Full electronic scale S.5.4. (1/1/94),
 Appendix A in EPO 13
 - Number of scale divisions (n) configured for the scale is less than or equal to n_{max} of the indicator or load cells, whichever is less.

For a full electronic scale, the verification scale division, v_{min} , for the load cells shall be less than or equal to the scale division, d, divided by the square root of the number of load cells, N:

$$v_{min} \leq \frac{d^*}{\sqrt{N}}$$

* When the value of the scale division, d, is different from the verification scale division, e, for the scale, the value of e shall be used in the above formula.

$$v_{min} \leq \frac{d^*}{\sqrt{N} \times (scale\ multiple)}$$

Verification scale division, v_{min} , for mechanical lever system scales with a single load cell:

Note: Maximum values of v_{min} for commonly encountered multiple load cell scales are listed in Appendix A in EPO 13.

- 9. Installation G-UR.2., UR.2.3.,
 UR.2.4., UR.2.5., UR.2.6.,
 UR.2.8.

If possible, observe normal weight determinations that are equal to or greater than the weight of the test equipment and test weights to verify the adequacy of the scale supports!

- 10. Approaches
 - Vehicle scales UR.2.6.1. (1/1/76)
 - Axle-load scales UR.2.6.2.

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Inspection (cont.)

- 11. Maintenance, use, and environmental factors.
 - Facilitation of fraud..... G-S.2.
 - Environment..... G-UR.1.2.
 - Operation G-UR.3.1.
 - Maintenance G-UR.4.
 - Maximum load UR.3.2.
 - Single draft vehicle weighing UR.3.3.
 - Manual gross weight entries UR.3.9.
 - Minimum load..... UR.3.7.
 - Scale modification UR.4.3.

- 12. Assistance..... G-UR.4.4.

Pretest Determinations:

- 1. Tolerances:
 - Acceptance/maintenance G-T.1., G-T.2.
 - Application:
 - Scales marked with an accuracy class T.N.2.1., T.N.2.3., T.N.2.4.
 - Tolerance values:
 - Scales marked with an accuracy class T.N.1.1, T.N.1.2.
 - Scales not marked with an accuracy class T.1.1./Table T.1.1.,
 - Both marked and unmarked scales T.N.3.1./Table 6 (Accuracy Class III L), T.N.3.2.
 - Discrimination T.N.7.2.
 - Repeatability..... T.N.5.
 - Agreement of indications..... T.N.4.1., T.N.4.2., T.N.4.4.

Note: Many "TN" tolerances apply to unmarked vehicle scales. See NIST HB 44 Table T.1.1. for a list of applicable "TN" paragraphs applicable to unmarked scales.

- 2. Determine maximum test load to be applied during test: A test load not to exceed marked concentrated load capacity (or for scales manufactured prior to January 1, 1989, the marked section capacity) may be applied to any section or between any two sections using the normal prescribed test pattern specified in N.1.3.3.1. A test load of 100 percent of capacity may be distributed over the entire platform.

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Pretest Determinations (cont.):

3. Minimum test weights and test loadsN.3., Table 4

SAFETY REMINDER!!!

- **Carefully inspect electrical supply lines, cables, chains, hydraulic lines, etc., on test equipment for wear or damage (e.g., electric weight carts, lifting equipment, etc.).**
- **Protect test equipment cables, power cables, hydraulic lines, etc., from damage during use.**
- **Correct potentially hazardous conditions before use (e.g., obstacles, water or other slippery conditions).**

Test Notes:

SAFETY REMINDER!!!

- **Wear appropriate personal protection equipment such as safety shoes to prevent possible injury from falling weights and slipping on slick surfaces and a hardhat to prevent injury from overhead hazards.**

1. Check repeatability of, and agreement between, indications throughout the test T.N.5., G-S.5.2.2.(a), G-S.5.2.2.(c)
2. Recheck zero-load balance each time the test load is removed..... N.1.9., G-UR.4.2.
3. If the scale is equipped with a printer, print ticket at each test load. If the device will print only one load without returning to “zero,” check printer with at least four different loads at convenient times during test..... G-S.5.6., UR.1.3. (1/1/86)

Also verify that any options for obtaining a recorded representation are appropriate. The customer may be given the option of not receiving the recorded representation. If the system is equipped with the capability, the customer may also be given the option of receiving the recorded representation electronically in lieu of or in addition to a hard copy..... G-S.5.6.

Check effectiveness of motion detection (See test procedure in Appendix C). S.2.1.2.(a), S.2.5.1.(a),

4. If, during the conduct of the test, the performance of the device is questionable with respect to the zone of uncertainty and the width of zero, additional tests may be conducted to determine compliance..... N.1.5. (1/1/86)* N,1.5.1.*, S.1.1.1.

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Test Notes (cont.):

5. If the device is equipped with operational features such as manual weight entries, programmable tare, multiple tare memory, weigh-in/weigh-out capability, or multiple weighing elements, check proper operation and appropriateness. G-UR.4.1, G-UR.4.2, S.4.3., S.1.12. (1/1/93) (1/1/05), UR.3.9., See also Appendix C for EPO 13

Test:

<p>SAFETY REMINDER!!!</p> <ul style="list-style-type: none">- WEAR SAFETY SHOES- USE PROPER LIFTING TECHNIQUES
--

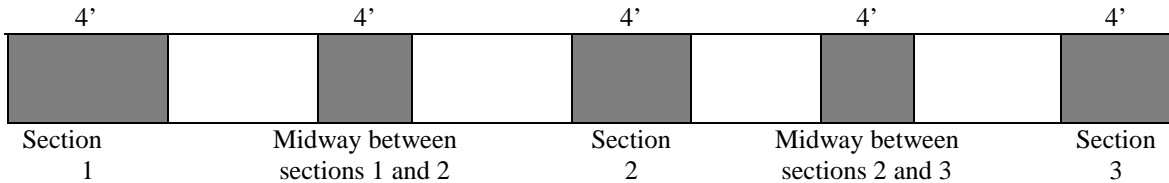
1. Discrimination test at or near zero load, if deemed necessary and if environmental conditions can be controlled N.1.5. (1/1/86)*, N.1.5.1.*
2. Test for proper configuration of automatic zero-tracking mechanism, if device is so equipped:
- Scales manufactured between January 1, 1981 and January 1, 2007 S.2.1.3.1.
 - Scales manufactured on or after January 1, 2007 S.2.1.3.2.
 - Means to disable AZT..... S.2.1.3.3. (1/1/01)
3. If equipped with a semi-automatic zero-setting mechanism (push button), test effectiveness of motion detection unless the mechanism is enclosed in a cabinet. S.2.1.2.(a), See Appendix C for EPO 13E (motion detection)
- Check proper design of tare auto-clear, if device is so equipped S.2.3. (including auto clear Note 1/1/83)
- Note:** On a vehicle scale, this requires a complete weighing transaction that includes the gross weight determination, input of tare, and net weight calculation.
4. Establish correct zero-load balance.
5. Increasing-load and shift (section) test..... N.1.1., N.1.3.3.

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Test (cont.):

Minimum shift (section) test: Conduct at least one shift test with a minimum test load of 12.5 percent of scale capacity anywhere on the load-receiving element using the prescribed test patterns and maximum test loads specified below.

Prescribed test pattern: An area of 1.2 meters (4 feet) in length and 3.0 meters (10 feet) in width or the width of the scale platform, whichever is less. When loading the scale for testing, one side of the test pattern shall be loaded to no more than one-half of the concentrated load capacity before loading the other side. An example of a possible test pattern is shown in the following diagram.



For test patterns less than 1.2 meters (4 feet) in length: Determine the maximum loading by the formula: [(wheelbase of test cart or length of test load ÷ 48 in) x 0.9 x CLC]

For test patterns that exceed 1.2 meters (4 feet): The maximum test load applied shall not exceed CLC x the largest “r” factor in Table UR.3.2.1. for the length of the area covered by the test load.

Multiple pattern loading: To test to the nominal capacity, multiple patterns may be simultaneously loaded in a manner consistent with the method of use.

Test load: The maximum test load applied to the prescribed test pattern shall not exceed the concentrated load capacity (or for scales manufactured prior to January 1, 1989, the rated section capacity).

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

Note: When testing scales manufactured prior to January 1, 1989, caution should be exercised when loading test weights equivalent to the rated section capacity onto areas between sections.

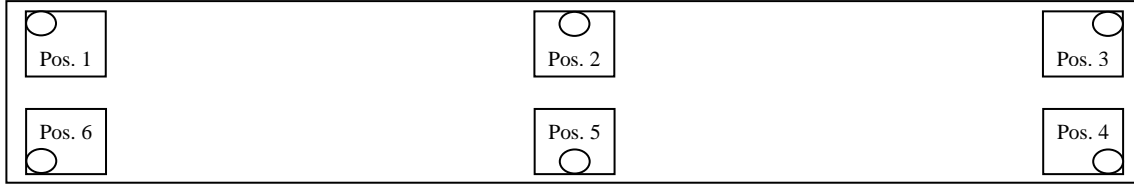
Note: When loading the first section to be tested, it is recommended that observations be made at each increment of test weight application.

- 6. Prescribed test pattern and test loads for combination vehicle/livestock scales with more than two sections. N.1.3.3.2.

A minimum test load of 5000 kg (10,000 lb) or one-half of the rated section capacity or CLC, whichever is less, shall be placed, as nearly as possible, successively over each main load support as shown below. Two section livestock scales shall also be tested consistent with N.1.3.7.

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○ = main load bearing point

- | | |
|---|--|
| 7. RFI/EMI Test. To test for effects of EMI and RFI using equipment found at the site in a manner that is <i>usual</i> and <i>customary</i> ² | G-N.2., G-UR.3.2.,
G-UR.4.2., G-UR.1.2.,
N.1.6., T.1.1., T.N.9.* |
| 8. Decreasing-load test, at one-half of maximum test load | N.1.2., N.1.2.2. |
| 9. Zero-load balance change | N.1.9., G-UR.4.2 |
| 10. Strain-load or substitution test on at least two sections; | N.1.11, N.1.12., N.3.
(See Appendix B for
EPO 13) |
| For strain-load tests: | |
| Position vehicle or some other object, material, etc. of unknown weight on one end of the load-receiving element of the scale. Use error weights to determine reference point within the displayed division before adding test weights. | |
| 11. Discrimination test at maximum test load, if deemed necessary and if environmental conditions are controlled..... | N.1.5. (1/186)*,
N.1.5.1.* |
| 12. Over capacity test (if practical)..... | S.1.7. |
| 13. Return to zero - check zero-load balance change..... | N.1.9., G-UR.4.2. |

² Procedures have been developed by the Scale Manufacturers Association and were adopted by the National Conference on Weights and Measures as part of the Final Report of the Committee on Specifications and Tolerances 63rd annual meeting, 1978. A revised SMA "Recommendation on Electrical Disturbance – SMA RED-0499" are available at www.scalemanufacturers.org by selecting the link to SMA Standards on the SMA homepage. SMA intends this document as an educational tool for manufacturers, distributors, inspectors, and customers.

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Examination Procedure Outline for

Vehicle and Axle-Load Scales
Part 2 - Mechanical-Analog Indicating

It is recommended that this outline be followed for vehicle and axle-load scales equipped with weighbeams and/or mechanical dials. Requirements that apply only to scales marked with an accuracy class are indicated with an asterisk. Non-retroactive requirements are followed by the applicable date in parentheses.

SAFETY NOTES: See EPO 13, Part 1.

**H-44 General Code and
Scales Code References**

Inspection:

SAFETY REMINDER!!!	
<ul style="list-style-type: none"> - Check the inspection site carefully for safety hazards and take appropriate precautions. - Learn the nature of hazardous products used at, or near, the inspection site. - Use caution when moving in wet, slippery areas. - Use personal protection equipment appropriate for the inspection site. - Position safety cones and warning signs if necessary. - Be sure that a first aid kit is available and that the kit is appropriate for the type of inspection activity. 	

1. Position of equipment	G-UR.3.3.
2. Zero-load balance as found.....	S.1.1., S.1.5.1., S.2.1.1., S.2.1.2., UR.4.1.
If the device is not indicating a zero-balance condition, the user should be made aware of paragraph UR.4.1. and a warning issued if necessary.	
3. Indicating and recording elements	G-S.5.
Weighbeams	S.1.5.
Poises.....	S.1.6.
Graduations, indicators, capacity indication.....	S.1.3., S.1.4., S.1.7.
Scale division, value (d) and number(n).....	S.1.2. (1/1/86)*, UR.1., UR.1.1.(b), UR.1.3. (1/1/86)
Tare division value	S.2.3. (1/1/83)
Tare mechanism	S.2.3.
Damping means.....	S.2.5.
Adjustable components	S.1.10.

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Inspection (cont.):

4. Suitability.....	G-UR.1.1., G-UR.1.2., UR.1., S.5.2. (1/1/86)*, UR.1.1., UR.3.1.*, UR.3.2. Customer readability, if applicable G-UR.3.3. Adjustable components S.1.10.
5. Design of weighing devices, accuracy class	S.5.*, S.5.4. (1/1/94), S.1.10., G-S.8. (1/1/90), G-UR.4.5.
6. Marking.	S.6.
Nominal capacity (Suitability)	S.6.1. (1/1/89)
Nominal capacity must satisfy the relationship of: nominal capacity ≤ CLC x (N - 0.5), where N = the number of sections in the scale	
a. Marking requirements - all devices	
Identification	G-S.1.
Name or ID of manufacturer	Retroactive
Model designation	Retroactive
Model prefix	(1/1/03)
Nonrepetitive serial number	(1/1/68)
Serial number prefix	(1/1/86)
Serial number – appropriate abbreviation.....	(1/1/01)
NTEP CC prefix and number (for devices that have an NTEP CC).....	(1/1/03)
Remanufacturer information, as appropriate:	
name and ID of remanufacturer	(1/1/02)
model number if different from original model number	(1/1/02)
Lettering	G-S.7.
Operational controls, indications, and features.....	G-S.6. (1/1/77)
Visibility of identification	G-UR.2.1.1.
Interchange or reversal of parts	G-S.4.
b. Marking requirements - indicating element not permanently attached or covered on separate CC (in addition to marking for all devices).....	
Accuracy class	S.6.3. (1/1/86)
Nominal capacity.....	Table S.6.3.b. Note 18
Value of scale division with nominal capacity, if not apparent.....	(1/1/83)
Value of "e" (if different from "d")	(1/1/86)

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Scales Code References**

Inspection (cont.):

b. Marking Requirements (cont.)

Maximum number of scale divisions (n_{max})	(1/1/88)
Concentrated load capacity (CLC)	(1/1/89)
Section capacity (Sec Cap) (see note below).....	Retroactive
Combination vehicle (CLC)/railway scales (Sec Cap)	(1/1/00)
Scales designed for special purposes	(1/1/86)

Note: Indicating elements manufactured prior to 1/1/89 are required to be marked with a section capacity rating. However, it is acceptable for these devices to be marked with a CLC instead. It is not permissible to substitute a section rating for a CLC on vehicle scales manufactured or placed into service on or after 1/1/89.

c. Marking requirements - weighing/load-receiving element not permanently attached or covered on separate CC (in addition to marking for all devices) S.6.3.

Location of Marking Information	S.6.2.
Accuracy class	(1/1/88)
Nominal capacity on weighing/load-receiving element	(1/1/89)
Maximum number of scale divisions (n_{max}).....	(1/1/88)
Minimum verification scale division (e_{min} or d_{min}).....	(1/1/88)
Concentrated load capacity (CLC)	(1/1/89)
Section capacity (Section Cap) (see note below).....	Retroactive
Combination vehicle (CLC)/railway scales (Section Cap).....	(1/1/00)
Scales designed for special purposes	(1/1/86)

Note: Weighing/load-receiving elements manufactured prior to 1/1/89 are required to be marked with a section capacity rating. However, it is acceptable for these devices to be marked with a CLC instead. It is not permissible, however, to substitute a section rating for a CLC on devices manufactured or placed into service on or after 1/1/89.

7. Weighing and load-receiving elements S.4., UR.2.8.
Access..... UR.2.5.

8. Installation G-UR.2., UR.2.3.,
UR.2.4.

<p>SAFETY REMINDER!!!</p> <p>– If possible, observe normal weight determinations that are equal to or greater than the weight of the test equipment and test weights to verify the adequacy of the scale supports!</p>
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9. Approaches
Vehicle scales UR.2.6.1. (1/1/76)
Axle-load scales UR.2.6.2.

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Inspection (cont.):

10. Maintenance, use, and environmental factors.	
Facilitation of fraud	G-S.2.
Environment	G-UR.1.2.
Operation	G-UR.3.1., G-UR.3.2.
Maintenance	G-UR.4.
Maximum load	UR.3.2.
Single draft vehicle weighing	UR.3.3.
Minimum load	UR.3.7.
Scale modification	UR.4.3.
11. Assistance	G-UR.4.4.

Pretest Determinations:

1. Tolerances.	
Acceptance/maintenance	G-T.1., G-T.2.
Application	T.N.2.1., T.N.2.3.
Principles	T.N.1.1., T.N.1.2.
Tolerance values:	
Scale marked with an accuracy designation.	
Maintenance tolerances	Table 6 (Class III L),
Acceptance tolerances	T.N.3.2.
Sensitivity (nonautomatic indicating scales)	T.N.6., T.N.6.1.,
	T.N.6.2.
Discrimination (automatic indicating scales)	T.N.7.1.
Agreement of indications	T.N.4.1., T.N.4.2.,
	T.N.4.3., and T.N.4.4.,
	(optional T.N.4.5.)
Repeatability	T.N.5.
Scale not marked with an accuracy class	T.1.1./Table T.1.1.
Maintenance tolerances	T.N.3.1.
	Table 6 (Class III L)
Acceptance tolerances	T.N.3.2.
Sensitivity requirement (SR) (nonautomatic indicating scales)	T.2.1., T.2.2., T.2.7., T.3.
Agreement of indications	T.N.4.1., T.N.4.2.,
	T.N.4.3., and T.N.4.4.
Repeatability	T.N.5.

Note: Many "T.N." tolerances apply to unmarked vehicle scales. See NIST HB 44 Table T.1.1. for a list of applicable "T.N." paragraphs applicable to unmarked scales.

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Pretest Determinations (cont.):

2. Determine maximum test load to be applied during test: a test load not to exceed marked Concentrated Load Capacity (or for scales manufactured prior to January 1, 1989, the marked Section Capacity) may be applied to any section or between any two sections. A test load of 100 percent of capacity may be distributed over the entire platform.
3. Minimum test weights and test loads N.3., Table 4

SAFETY REMINDER!!!

- **Wear appropriate personal protection equipment such as safety shoes to prevent possible injury from falling weights and slipping on slick surfaces and a hard hat to prevent injury from overhead hazards.**

Test Notes.

SAFETY REMINDER!!!

- **Carefully inspect electrical supply lines, cables, chains, hydraulic lines, etc., on test equipment for wear or damage (e.g., electric weight carts, lifting equipment, etc.)!**
- **Protect test equipment cables, power cables, hydraulic lines, etc., from damage during use!**
- **Correct potentially hazardous conditions before use (e.g., obstacles, water or other slippery conditions)!**

Note: If the scale uses a beam indicating element (e.g., full- or type-registering beam), balance small error weights on the platform, the smallest weight equal to the minimum tolerance value and the total value of the weights being equal to the tolerance value at maximum test load.

1. Check repeatability of, and agreement between, indications throughout the test..... T.N.4. T.N.5., G-S.5.4.
2. Recheck zero-load balance each time test load is removed..... N.1.9., G-UR.4.2.
3. If the scale is equipped with a type-registering (T.R.) beam or a printer, print ticket at each test load..... G-S.5.6., UR.1.3.
(1/1/86)*,
G-S.5.2.2.(b)

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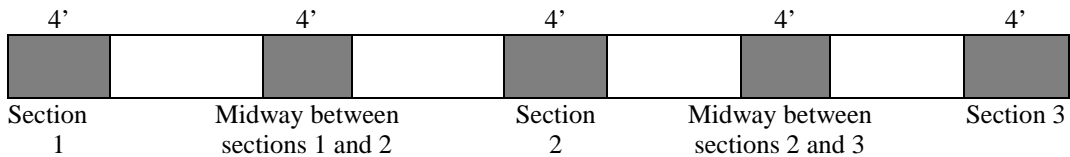
H-44 General Code and Scales Code References

Test:

SAFETY REMINDER!!!
 – **WEAR SAFETY SHOES!**
 – **USE PROPER LIFTING TECHNIQUES!**

1. Sensitivity test at zero load (for weighbeams and balance indicators only) N.1.4.
 Discrimination (dials and balance indicators with graduations having a specific value only) N.1.5. (1/1/86),* T.N.7.1.
2. Increasing-load and shift (section) test. N.1.1., N.1.3.
 - a. If beam scale, test at not less than two points on each weighbeam.
 - b. If automatic-indicating scale, test at not less than three points on reading face, including all possible quarters of the reading-face capacity. Test all unit weights possible.

 N.1.3.3.1.(a)
 - c. Minimum shift test
 - **Minimum shift test:** Conduct at least one shift test with a minimum test load of 12.5 percent of scale capacity anywhere on the load receiving element using the prescribed test patterns and maximum test loads specified below.
 - **Prescribed test pattern:** An area of 1.2 meters (4 feet) in length and 3.0 meters (10 feet) in width or the width of the scale platform, whichever is less. When loading the scale for testing, one side of the test pattern shall be loaded to no more than one-half of the concentrated load capacity before loading the other side. An example of a possible test pattern is shown in the following diagram.



- For test patterns less than 1.2 meters (4 feet) in length: Determine the maximum loading by the formula: [(wheelbase of test cart or length of test load ÷ 48 in) x 0.9 x CLC]
- For test patterns that exceed 1.2 meters (4 feet): The maximum test load applied shall not exceed CLC x the largest “r” factor in Table UR.3.2. for the length of the area covered by the test load.
- Multiple pattern loading: To test to the nominal capacity, multiple patterns may be simultaneously loaded in a manner consistent with the method of use.

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Test (cont.)

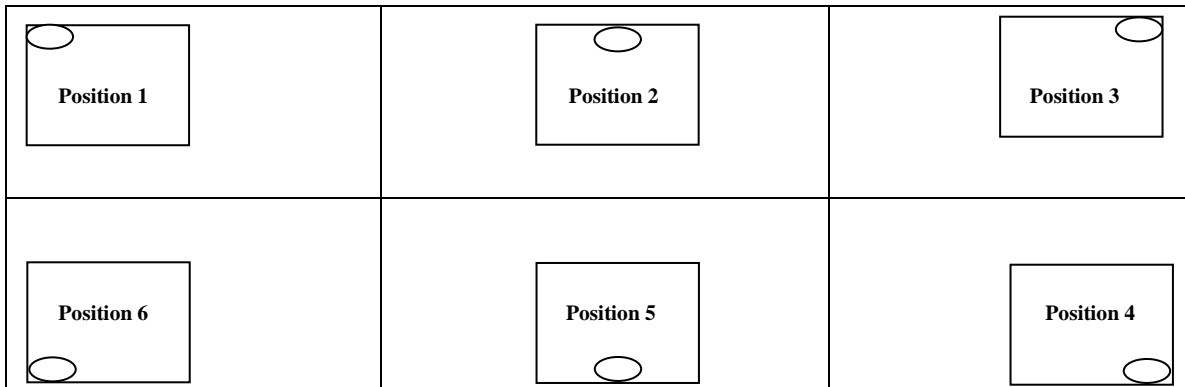
- Test load: The maximum test load applied to the prescribed test pattern shall not exceed the concentrated load capacity (or for scales manufactured prior to January 1, 1989, the rated section capacity).
- Other designs: Special design scales and those that are wider than 3.7 meters (12 feet) shall be tested in a manner consistent with the method of use but following the principles described above.

Note: When testing scales manufactured prior to January 1, 1989, caution should be exercised when loading test weights equivalent to the rated section capacity onto areas between sections.

Note: When loading the first section to be tested, it is recommended that observations be made at each increment of test weight application.

3. Prescribed test pattern and test loads for combination vehicle/livestock scales with more than two sections.

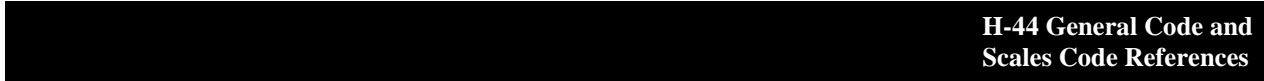
A minimum test load of 5000 kg (10,000 lb) or one-half of the rated section capacity or CLC, whichever is less, shall be placed, as nearly as possible, successively over each main load support as shown below. Two section livestock scales shall also be tested consistent with N.1.3.7.



○ = Load Bearing Point

4. Decreasing-load test (automatic-indicating only), at one-half of maximum test load. (for dials, test at no less than one-half dial-face capacity)..... N.1.2., N.1.2.2.
5. Strain-load or substitution test on at least two sections N.1.11., N.1.12., N.3., T.N.3.11., T.N.3.12.
 - Strain-load Tests: Follow the procedures in Appendix B for EPO 13. Tolerances apply only to the test weights or substitution test load.
 - Substitution Test: Follow the procedures in Appendix B for EPO 13. Tolerances are applied to the substitution test load.

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Scales Code References**

Test (cont.)

- 6. Sensitivity test at maximum test load (weighbeams and balance indicators only) N.1.4.
 Discrimination (dials and balance indicators with graduations having a specific
 value only)..... N.1.5. (1/1/86),* T.N.7.1.
- 7. Remove test load and determine any zero-load balance change..... N.1.9., G-UR.4.2.
- 8. Remove error weights and establish correct zero-load balance.

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Appendix A - Maximum Values of Multiple Load Cell Scales

(Table values are in pounds.)

Full electronic scales

Example: For a vehicle scale with four sections (eight load cells) and a displayed scale division of 20 lb, the maximum value permitted for each load cell is 7.1 lb. The calculation is shown below. If the value marked on the load cell is less than or equal to the value computed for the v_{\min} , then the load cell is considered to comply with T.N.8.1.3.

$$v_{\min} \leq \frac{d^*}{\sqrt{N}} = \frac{20 \text{ lb}}{\sqrt{8}} = \frac{20 \text{ lb}}{2.83} = 7.07 \text{ lb rounded to } 7.1 \text{ lb}$$

No. of Load Cells	Scale Division (lb)						
	1	2	5	10	20	50	100
	Minimum v_{\min} rating for each cell (lb)						
2	0.71	1.41	3.54	7.07	14.1	35	70
4	0.50	1.00	2.50	5.00	10.0	25	50
6	0.41	0.82	2.04	4.08	8.2	20.4	41
8	0.35	0.71	1.77	3.54	7.1	17.7	35
10	0.32	0.63	1.58	3.16	6.3	15.8	32
12	0.29	0.58	1.44	2.89	5.8	14.4	29
14	0.27	0.53	1.34	2.67	5.4	13.4	27

Mechanical Scales with single load cell

Example: Calculate the multiple of the lever system from the ratios marked on the levers. Suppose the multiple for a vehicle scale is 400:1 and that the scale has a scale division of 20 lb. Then the maximum value for the v_{\min} of the load cell is 0.05 lb. The calculation is shown below. If the load cell is marked with a v_{\min} less than or equal to the calculated value, then the load cell is considered to comply with T.N.8.1.3.

$$v_{\min} \leq \frac{d^*}{\sqrt{N} \times (\text{scale multiple})} = \frac{20 \text{ lb}}{\sqrt{1} \times 400} = 0.05 \text{ lb}$$

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Appendix B - Strain-Load and Substitution Load Method of Testing

(Excerpt from NBS Handbook 94 – Out-of-print)

and

Strain-Load Testing Using Error Weights

(Excerpt from OWM Newsletter Archive)

When Test-Weight Load is Inadequate. In the test of a large-capacity scale where the amount of test weights available is less than the "used" or full capacity of the scale, it is necessary for the inspector to resort to a substitution method of test (which may be referred to as a "build-up" or "step" test), or to the use of from one to several "strain" loads in addition to the available load of test weights. The former method is generally the better when carefully carried out but will usually consume a considerably greater amount of time than the strain-load method.

Substitution Method of Testing. The principle of the substitution method of test is the successive substitution for the test-weight load of a load of any available material, whereby a total known load of any number of times the value of the available test weights is gradually built up, the scale under examination being utilized for the determination of each substituted load. For example, assume a 40 000-pound vehicle scale that must be tested with only 10,000 pounds of test weights. The test would be made in the ordinary way up to the point where the distributed load on the platform is 10,000-pounds - all of the available test weights. By means of small weights and/or the movement of a poise, if necessary, the scale would then be brought to a readily reproducible condition of balance, such as the exact coincidence between the indicator and some graduation, or a weighbeam that just fails to "bump" when released. Then the 10,000 pounds of test weights would be removed, great care being exercised not to disturb the scale mechanism in any way that would affect the balance condition, and any material available would be carefully added to the platform until the former condition of balance had been reproduced; assuming the scale under test to be capable of repeating its indications, it is apparent that there would now have been added to the platform just 10,000 pounds of material within that degree of accuracy determined by the ability of the scale to duplicate the original balance condition. In other words, there would now be available 20,000-pound known load consisting of 10,000 pounds of test weights and 10,000 pounds of other material. If now any poise that had been moved were restored to its original position and any small weights that may have been utilized in establishing the reproducible balance condition were to be removed, the scale would be in just the same condition as though the test had just been started with 20,000 pounds of test weights and had proceeded to the point where 10,000 pounds of that amount had been used.

The test would then proceed as before until the platform load reached 20,000 pounds, when another substitution would be made in the same manner as has been outlined. *[No more than three substitutions shall be used during substitution testing, after which the tolerances for strain load tests shall be applied to each set of tests. (HB 44 2.20 Table 4 Note 2)]*

It may well be repeated that in making these substitutions the greatest care must be exercised each time weights are removed and material is added, to avoid disturbing the scale mechanism in any way that would affect the balance condition; similar care must likewise be used in establishing and duplicating the balance condition on which the substitution depends for its accuracy. Some error is inevitable at each substitution, and unless this error is held down to a minimum, the accumulated error after several substitutions may reach serious proportions.

Another caution that must be observed during a substitution test is never to change the adjustment of the regular balancing means of the scale during the progress of the test. When a temporary balancing operation is made necessary in order to establish a reproducible balance condition prior to removal of the test-weight load, the inspector must always restore the original conditions that prevailed when the scale was originally balanced at zero

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Appendix B (continued)

after the substitution is completed and before proceeding with the test; this cannot be done with precision if the adjustment of the regular balancing means has been changed, hence the instruction that these temporary balancing operations be performed by means of poise movement or weights added to platform or counterpoise hanger. When a full-capacity beam scale has an error of overregistration and is equipped with a notched fractional bar, it may be necessary to accomplish this temporary balancing by setting the fractional poise out one or more notches until the beam is balanced low, and then adding enough small weights to the platform to produce the desired balance; when an automatic-indicating scale has a similar error, enough small weights may be added to the platform to bring the indicator into coincidence with the next forward graduation so that a precise reading can be made³.

Strain-Load Method of Testing. (*NBS Handbook 94 discussion on Strain-Load Method has been deleted. WMD recommends using the procedure outlined in the newsletter article following the excerpts of Handbook 94.*)

Tolerance Application on Substitution and Strain-Load Tests. There is an important difference between the substitution method and the strain-load method in the manner of applying the tolerances. In the substitution method, the entire load on the load-receiving element of the scale at the time of making any test observation is regarded as *known* load, and any observed error is an error on the *total* load on the scale. In the strain-load method, observed errors are errors on the *test-weight load only*, since before each application of the test-weight load the strain load of unknown value has been balanced out; accordingly, the tolerances to be applied are to be selected according to the value of the *test-weight load* in each instance of an accuracy observation under the strain-load method.

Strain-Load Testing Using Error Weights

(Excerpt from OWM Newsletter Quarterly Archive at <http://www.nist.gov/pml/wmd/pubs/upload/A-009.pdf> or <http://www.nist.gov/pml/wmd/pubs/newsletter-archives.cfm>)

In the strain-load test of a scale, an unknown quantity of material or objects is applied to the load-receiving element of a scale to establish a reference load to which test weights are then added. The strain-load test is used to determine the accuracy of a portion of the total weighing range of a scale. Field personnel frequently utilize strain-load tests when testing large capacity scales so that accuracy can be verified in the weighing ranges where many of these scales are typically used. Strain-load tests are also frequently utilized when the amount of test weight available for testing is less than the minimum test loads required under Table 4 of the Scales Code in NIST Handbook 44.

To properly perform a strain-load test, error weights should be used to determine a reference point for the unknown load prior to adding the test weights to complete the test. Failure to determine a specific reference point using error weights can cause unacceptable errors in the performance results of this particular test. OWM frequently receives inquiries regarding the use of error weights in testing scales. The paragraphs below describe procedures for conducting strain-load tests, including procedures for determining necessary reference points, on scales having beam and digital indication.

³ See the OWM article on the use of error weights at the end of this appendix to determine the breakpoint between adjacent scale divisions on an electronic or mechanical automatic indicating scale.

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Appendix B (continued)

Using Error Weights on a Digital Scale. To perform the strain-load test on a scale having digital indications, error weights are used to establish, as a reference point, the center of the displayed division representing the unknown load. Once the center of the displayed division has been established, test weights can then be added and scale errors determined by direct reading of the indication. The procedure for conducting a strain-load test on a scale having digital indications is as follows:

1. Apply 10 error weights, each having a value of 0.1 d, to the platform and zero the scale.
2. Apply the unknown load. Record the displayed value and identify it as the weight of the unknown load.
3. Remove error weights from the platform in 0.1 d increments until the indication just begins flashing to the next lower division.
4. In a separate location on the platform begin a second group of error weights by adding back all of the error weights that were just removed in the previous step.
5. Continue adding additional error weights to this second group in 0.1 d until the displayed indication just begins flashing to the next higher division.
6. Total the error weight in the second group and remove one-half of it from the platform. Doing so places the indication at the proper reference, i.e., in the center of the displayed division and properly establishes your reference point for the strain-load test.
7. Apply known test weights in predetermined increments or all at one time.
8. Add the weight of the unknown load (determined in step 2) to the value of the known test weights applied.
9. Scale error is determined by subtracting the summed value from step 8 from the displayed indication.

After performance results have been determined and recorded for all of the test weights, return weights equal to one division to the scale platform, remove the known test weights and the unknown load, and verify that the scale returns to zero.

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Appendix C - Tests for Motion Detection

A digital electronic device must have a motion detection capability that prevents the device from zeroing (push-button zero) or taring (pushbutton tare) part of a load when the semi-automatic zero or tare key is activated at the same time that a load is added, changed, or removed from the scale.

A digital electronic scale equipped with a printer must have a motion detection capability that prevents the scale from printing weight values before the weight display has stabilized within specified limits. This reduces the possibility of recording incorrect weight values. The limits for motion detection are:

- (a) plus or minus 3 scale divisions for:
 - a. axle-load,
 - b. railway track,
 - c. vehicle scales,
 - d. combination vehicle/livestock scales,
 - e. combination vehicle/railway track scales and
 - f. hopper (other than grain hopper) scales with a capacity exceeding 22 000 kg (50 000 lb); and
- (b) plus or minus 1 scale division for all other scales.

The following procedure is recommended to test the effectiveness of motion detection for printing, push-button zero, push-button tare, and storing a weight value in a memory register.

For higher capacity scales, apply or remove a load of greater than 15d while activating the following functions (e.g., pressing the applicable pushbutton, switch, etc.):

- semiautomatic (pushbutton) zero-setting,
- semiautomatic (pushbutton) tare,
- storing a gross, net or tare weight value, or
- printing a ticket, receipt, invoice, etc.

It is important to insure that peak oscillations of greater than 15d are induced. These tests can usually be performed as test weights are being placed on or removed from the weighing/load-receiving element.

Indicated, stored, and recorded weight values must be within 3 divisions (3d) of the value obtained under static conditions for vehicle, axle-load, and railway track scales. All recorded values shall be within applicable tolerances.