## EPO No. 13E

### Examination Procedure Outline for

# Vehicle and Axle-Load Scales Electronic-Digital Indicating

It is recommended that this outline be followed for vehicle and axle-load scales equipped with electronic digital indicators. 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 "Safety Considerations" section and the "Glossary of Safety Key Phrases" should be duplicated and included with the outline.***

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. The inspector should read and be familiar with the introductory section on safety found at the beginning of this publication. As a minimum, the following safety precautions should be noted and followed during the inspection. Definitions of each reminder are found in the "Glossary of Safety Key Phrases" at the back of this publication.

***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 to 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.***

**Clothing**

**Electrical Hazards**

**First Aid Kit**

**Lifting**

**Location**

also: **Wet/Slick Conditions**
**Chemicals, Petroleum Products & 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**

## EPO No. 13E

## *Inspection:*

### Safety First

**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 in 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.**

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

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.
   - Digital zero ..... G-S.5.2.2.(d) (1/1/86)
   - Digital indicating elements ..... S.1.1.1.
   - Zero-load adjustment ..... S.2.1.1., S.2.1.2., S.2.1.3., (1/1/81), S.2.1.3.1. (1/1/01)

3. Indicating, and recording elements.
   - Appropriateness ..... G-S.5.1.
   - Graduations, indications, and recorded representations ..... G-S.5.1.
   - 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 ..... G-S.5.6., UR.1.3. (1/1/86)
   - Magnified graduations and indications ..... G-S.5.7.
   - Rounding ..... G-S.5.2.2.(c)
   - Manual Gross Weight Entries ..... S.1.12.(1/1/93),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.*, S.5.4. (1/1/94), S.1.10., G-S.8. (1/1/90) G-UR.4.5., S.1.11.(a) (1/1/79) S.1.11.(b) (1/1/90) S.1.11.(c) (1/1/95)

## EPO No. 13E

## *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.6.3., S.6.2.
   Nominal capacity ..... S.6.1. (1/1/86)
   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 ..... (1/1/68)
      Serial number prefix ..... (1/1/86)
      Serial number – appropriate abbreviations ..... (1/1/01)
      NTEP CC prefix and number ..... (1/1/03)
      (for devices that have an NTEP CC)
      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 - 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 other than -10 $^0$C to 40 $^0$C (14$^0$F to 104 $^0$F) ..... (1/1/86)
      Scales designed for special purposes ..... (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 other than -10 $^0$C to 40 $^0$C (14 $^0$F to 104 $^0$F) ..... (1/1/86)
      Concentrated load capacity (CLC) ..... (1/1/89)
      Section capacity (see note below) ..... Retroactive
      Scales designed for special purposes ..... (1/1/86)
      Maximum number of scale divisions ($n_{max}$) ..... (1/1/88)

## EPO No. 13E

## *Inspection (cont.)*

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 on load receiving element ..... (1/1/89)
- Concentrated Load Capacity (CLC) or Section Capacity (see note below) ..... (1/1/89)
- Temperature limits if other than -10 $^0$C to 40 $^0$C (14 $^0$F to 104 $^0$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) ..... (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)
- Accuracy class ..... (1/1/86)
- Temperature limits if other than -10 $^0$C to 40 $^0$C (14 $^0$F to 104 $^0$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)

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).

Note: Indicating and weighing 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.

**Check to be sure the scale supports are adequate to support the scale, test equipment, <u>and</u> test weights equal to the capacity of the scale !**

7. Design of weighing elements ..... S.4.

8. Load cell installation

Full electronic scale ..... T.N.8.1.3., S.5.4. (1/1/94) Appendix to EPO 13-E

Number of scale divisions, n, $\leq n_{max}$ of the indicator or load cells, whichever is less.

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:

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

**<u>Note:</u>** Compliance with T.N.8.1.3. cannot be determined in the field. The $v_{min}$ value on the load cell is used to determine compliance with T.N.8.1.3. The $v_{min}$ value marked on the load cell must be less than or equal to the $v_{min}$ value in the table of Appendix A of this EPO based upon the d and N for the scale; if it is not, the scale does not comply with T.N.8.1.3. (See also 1988 OWM paper on "Device Regulation Under the New Scales Code.")

Mechanical lever systems with a single load cell:

# EPO No. 13E

$$v_{min} \leq \frac{d}{\text{scale multiple}}$$

**Note:** Maximum values of $v_{min}$ for commonly encountered multiple load cell scales are listed in the Appendix to EPO 13E.

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

10. 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.

11. Assistance ..... G-UR.4.4.

## EPO No. 13E

## *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.3.1./Table 6 (Accuracy Class III L), T.N.3.2.
     - Scales not marked with an accuracy class..... T.1.1., T.N.3.1./Table 6 (Class III L), T.N.3.2.,
     - Other applicable requirements ..... T.N.4.1., T.N.4.2., T.N.4.3., T.N.4.4., T.N.5. T.N.7.2.
   - Note: Some TN tolerances apply to unmarked vehicle scales, see NIST HB 44 Table T.1.1.

   - Discrimination..... T.N.7.2.

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

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

## EPO No. 13E

## *Test Notes:*

**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 test. ..... T.N.5., G-S.5.2.2.(a), G-S.5.2.2.(c)

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 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. Check effectiveness of motion detection. ..... G-S.5.6., S-2.5.1.(a), UR.1.3. (1/1/86)*

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.

5. If the device is equipped with operational features such as manual weight entries, programmable tare, multiple tare memory, weigh-in/weigh-out, 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), UR.3.9., See also - Type Evaluation Handbook

## EPO No. 13E

## *Test:*

**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-setting mechanism, if device is so equipped. ..... S.2.1.3.(b) (1/1/81) S.2.1.3.1. (1/1/01)

3. If equipped with a semi-automatic zero-setting mechanism (push button), test effectiveness of motion detection ..... Type Evaluation Handbook; S.2.1.2.(a)

4. Check proper design of tare auto-clear, if device is so equipped..... S.2.3. (including note for auto clear 1/1/83)

5. Establish correct zero-load balance.

6. Increasing-load and shift (section) test ..... .N.1.1., N.1.3.4., N.1.3.4.1., N.1.3.4.2.

   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.

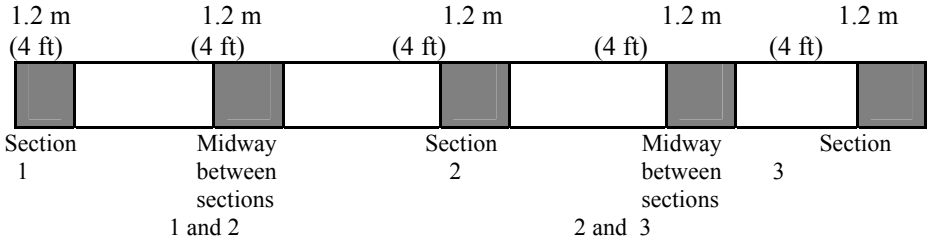
   Prescribed test pattern: An area of 1.2 meters (4 feet) in length and 3.0 meters (10 feet) in width or the width of the scale platform, whichever is less. When loading the scale for testing, one side of the test pattern shall be loaded to no more than one-half of the concentrated load capacity before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

   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.

   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.




   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).

## EPO No. 13E

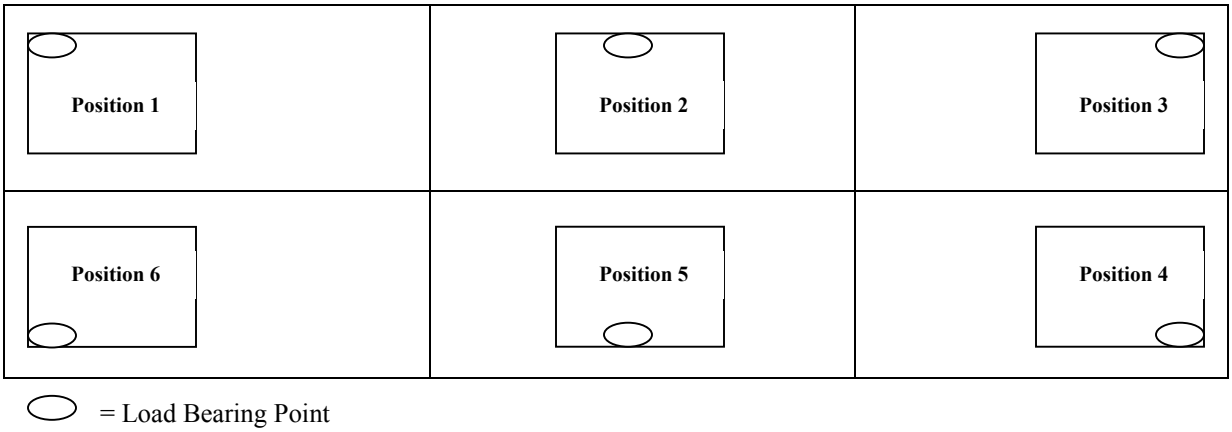
## *Test (cont.)*

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.

Note: For weighing elements installed prior to 1/1/89, the rated section capacity may be substituted for concentrated load capacity to determine maximum loading.

Prescribed test pattern and test loads for combination vehicle/livestock scales with more than two sections..... N.1.3.4.2.
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.1.3.8.




7. RFI/EMI Test.
To test for EMI, use procedures outlined in SMA Test Procedures[1]. To test for effects of RFI, use equipment found at the site in a manner that is usual and customary ..... G-N.2., G-UR.3.2., G-UR.4.2., G-UR.1.2., N.1.6., T.4., T.N.9.*

8. Decreasing-load test, at one-half of maximum test load..... ..... ..... N1.2., N.1.2.2.

[1]These procedures, developed by the Scale Manufacturers Association, 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 (copies of the 1978 procedures are available). Also reference SMA Recommendation on Electrical Disturbance – SMA RED-0499 (copies of SMA RED-0499 are available at www.scalemanufacturers.org)

## EPO No. 13E

## *Test (cont.)*

9. Zero-load balance change ..... N.1.9., G-UR.4.2

10. Strain-load or substitution test on at least two sections; ..... N.1.1. (See Appendix B) at the end of this EPO)

For strain-load tests, position vehicle on one end of scale; Using error weights, determine reference point within the displayed division.

Distribute test weights on other end of scale. Determine error-using reference point noted above. The tolerances are selected based upon the value of the test load only.

11. Discrimination test at maximum test load, if deemed necessary and if environmental conditions are controlled ..... N.1.5. (1/1/86)*, N.1.5.1.*

12. Over-capacity test (if practical) ..... S.1.7.

13. Recheck zero-load balance change ..... N.1.9., G-UR.4.2.

# EPO No. 13E

## Appendix A to EPO No. 13E

## Maximum Values of Multiple Load Cell Scales (Table values are in pounds.)

| Load Cells | Scale Division 1 lb | 2 lb | 5 lb | 10 lb | 20 lb | 50 lb | 100 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 |

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.

$$v_{min} \leq \frac{d}{/\,N} = \frac{20\text{ lb}}{/\,8} = \frac{20\text{ lb}}{2.83} = 7.07\text{ lb} \sim 7.1\text{ lb}$$

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.

$$v_{min} \leq \frac{d}{\text{scale multiple}} = \frac{20\text{ lb}}{400} = 0.05\text{ lb}$$

# EPO No. 13E

## Appendix B to EPO No. 13E

## Strain-Load Method of Testing
(Excerpts from NBS Handbook 94)

**Description of Test.** When the supply of test weights is inadequate, the principle involved in the use of strain loads is that the known test load is first applied when the scale is carrying no other load (this is frequently referred to as the "light test"), and is subsequently applied one or more times when the scale is under some additional but unknown load that stresses the parts as they are normally stressed under ordinary operating conditions. Under this method, the actual values of the strain loads - which may consist of miscellaneous material, loaded vehicles, grain in a hopper, and the like - are immaterial and are not determined, the strain loads being simply "balanced out" by any convenient means. (The regular balancing means of the scale could be utilized when arriving at the final balance for a strain load, but this has the disadvantage that the scale cannot then be checked at the conclusion of the test for a possible shift of its zero-load balance; for this reason, use of the regular balancing means is not recommended here.) Thus, after carrying the light test of a motor-truck scale, for instance, as far as may be done with the test weights available, and assuming that it is next desired to make a test in the region up to one-half the nominal scale capacity, the test weights would be removed and a vehicle would be driven onto the platform and the scale brought to a balance; this vehicle would have been so selected that the sum of its gross weight and the total value of the test weights would approximate one-half the nominal capacity of the scale. The test weights would then be added, in one or in several increments, and it would be observed whether or not the scale properly indicated the value of each increment of test weights added. Following this, another strain load would be added, of such a value that the combined weight of the strain load and test weights would approximate the value in the region of which it is desired to make the next test; this strain load would then be balanced out and the test weights subsequently added as in the earlier part of the test. This operation may be repeated any desired number of times as long as the gross load does not exceed the weighing capacity of the scale; however, assuming that a reasonably satisfactory amount of test weights is available, not more than two strain loads will ordinarily be utilized, the scale being tested light and when loaded to approximately one-half and full capacities.

**Tolerance Application on Strain-Load Tests.** 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.