EPO No. 13E

Examination Procedure Outline for

Vehicle and Axle-Load Scales
Electronic-Digital Indicating

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It is recommended that this outline be followed for 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 EPO Safety Annex (Safety Considerations and Glossary of Safety Key Phrases) should be duplicated and included with this outline.

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.

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, 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

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 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 S.5.4. (1/1/94)
   - Assistance ..... G-UR.4.4.

	H-44 General Code and Scales Code References

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 (for devices that have an NTEP CC)	(1/1/03)
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]
Combination vehicle (CLC)/railway scales (Sec Cap)	(1/1/00)

[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.

Inspection (Cont.)

Scales designed for special purposes	S.6.3. (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!

7. Design of weighing/load-receiving elements	S.4. UR.2.8.
Access	UR.2.5.

Inspection (cont.)

8. Load cell installation and suitability

Full electronic scale ..... S.5.4. (1/1/94) Appendix A in EPO 13-E

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 13E.

	H-44 General Code and Scales Code References
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.
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.

Inspection (cont.)

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.,
Tolerance values:	
Scales marked with an accuracy class	T.N.2.4.
Scales not marked with an accuracy class	T.N.1.1, T.N.1.2., T.1.1./Table T.1.1., 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.	N.4.1., T.N.4.2., T.N.4.3., 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.

	H-44 General Code and Scales Code References

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.

3. Minimum test weights and test loads ..... N.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.

   Check effectiveness of motion detection (See test procedure in Appendix C). ..... G-S.5.6., S.2.1.2.(a), S.2.5.1.(a), UR.1.3. (1/1/86) Appendix C for EPO 13E.

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.

	H-44 General Code and Scales Code References
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 13E

H-44 General Code and Scales Code References

Test:

SAFETY REMINDER!!!

- **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)

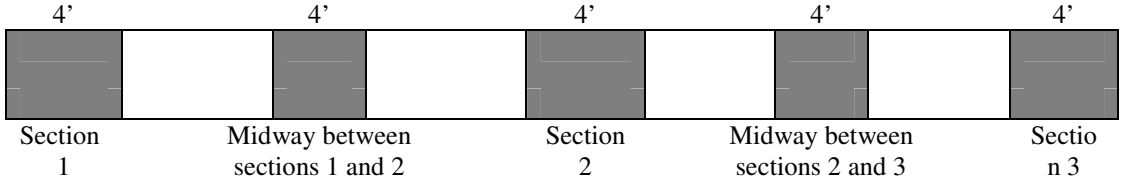
   Note: On a vehicle scale, this requires a complete weighing transaction that includes the gross weight determination, input of tare, and net weight calculation.

   Establish correct zero -load balance.

   Increasing -load and shift (section) test ..... N.1.1., N.1.3.3.

   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.



Test (Cont.)

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 ÷ 7 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).

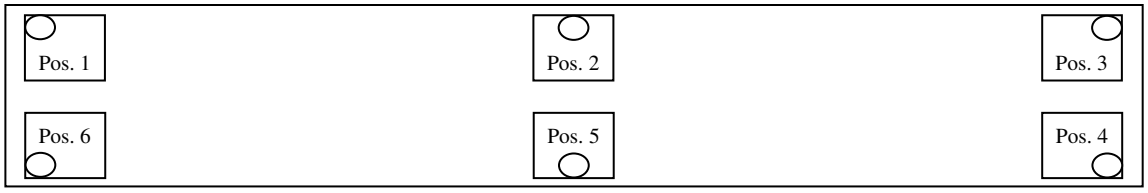
Other designs: Special design scales and those that are wider than 3.7 meters (12 feet) shall be tested in a manner consistent with the method of use but following the principles described above.

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.

4. Prescribed test pattern and test loads for combination vehicle/livestock scales with mc
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.



⬭ = main load bearing point

	H-44 General Code and Scales Code References

Test (Cont.)

5. RFI/EMI Test.To test for effects of EMI and RFI using equipment found at the site i	G-N.2., G-UR.3.2., G-UR.4.2., G-UR.1.2., N.1.6., T.1.1., T.N.9.*
6. Decreasing-load test, at one-half of maximum test load.....	N.1.2., N.1.2.2.
7. Zero-load balance change	N.1.9., G-UR.4.2
8. Strain-load or substitution test on at least two sections;	N.1.11, N.1.12., N.3.
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.	(See Appendix B for EPO 13E)
9. 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.*
10. Over-capacity test (if practical)	S.1.7.
11. Recheck 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.

Appendix A to EPO No. 13E

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.

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

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.

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

Appendix B to EPO No. 13E

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

Appendix B to EPO No. 13E (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 made[3].

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. WMD frequently receives inquires 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.

Appendix B to EPO No. 13E (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.

Appendix C to EPO No. 13E

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.