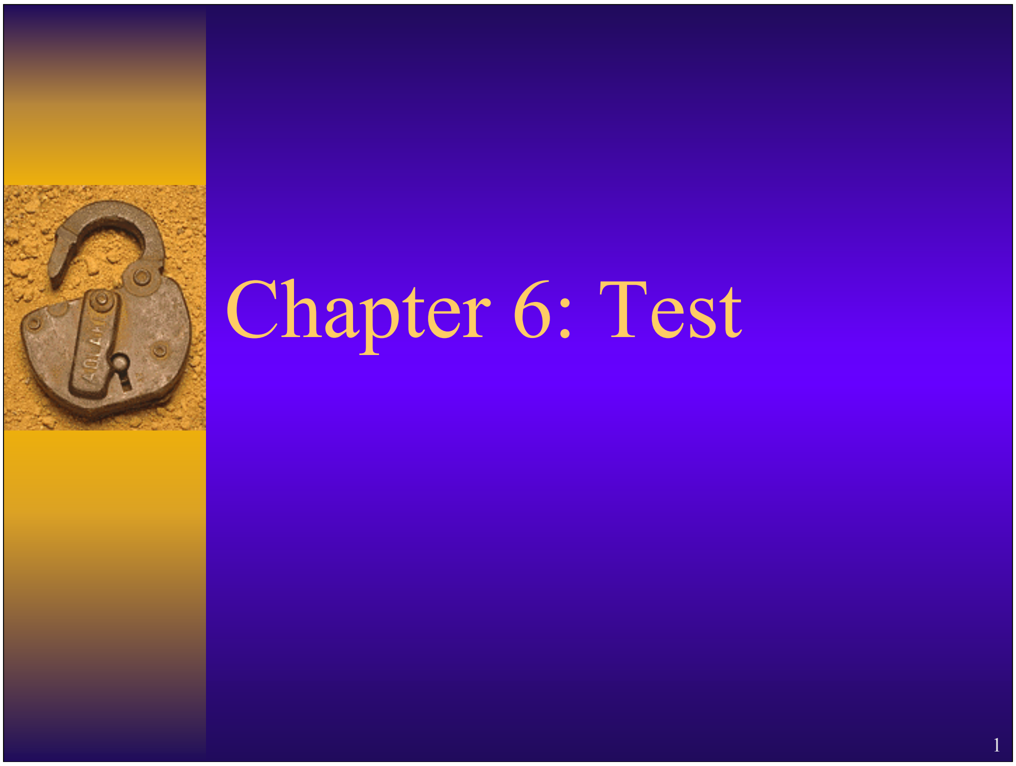


Chapter 6 Objectives

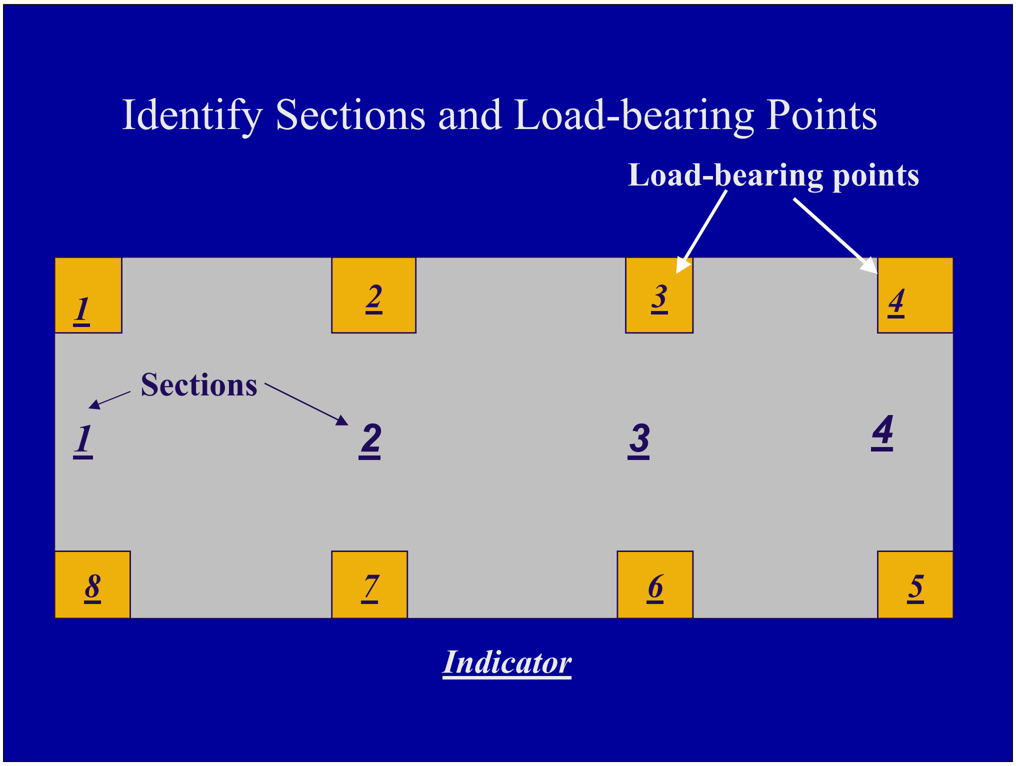
1. Describe procedures for conducting the various performance tests as prescribed by the EPOs.
2. Describe procedures for conducting the discrimination test on a digital indicating vehicle or axle-load scale.
3. Identify and describe the procedures for conducting indicator specific tests.
4. Describe procedures for testing the semi-automatic and automatic zero setting mechanisms and motion detection.
5. Describe the recent changes to HB 44 relating to shift tests and scale loading precautions.
6. Describe the error and tolerance methods of testing.
7. Describe how errors observed in official tests are recorded on the report form for both automatic and non-automatic indicating scales.

Note: Before introducing the slide presentation for each chapter, it is recommended that the presenter read the course material for the chapter in its entirety and refer to the written material as needed while using the slide presentation to illustrate and explain the text.

Planning the Test

- What are the scale's:
  - nominal and used capacity?
  - CLC or section rating?
- What is the value of d?
- How much known weight do you have and how is it broken down?
- Define the test pattern and placement of standards during testing.
- What other tests will be needed?

Explain why each of the bulleted items above are included as part of planning the test. Include an explanation of how the capacities of a vehicle and axle-load scales affect the minimum amount of test weight and test loads that are necessary to conduct adequate tests. When explaining why it is important to define the test pattern and placement of standards, note the reason that this bulleted item was included in this list; some test carts in official use have a wheelbase length less than 48 inches necessitating the user to calculate maximum loading using the formula prescribed in N.1.3.4. Remember that HB 44 recommends the minimum number of tests that should be performed and it is always permissible to perform additional testing.

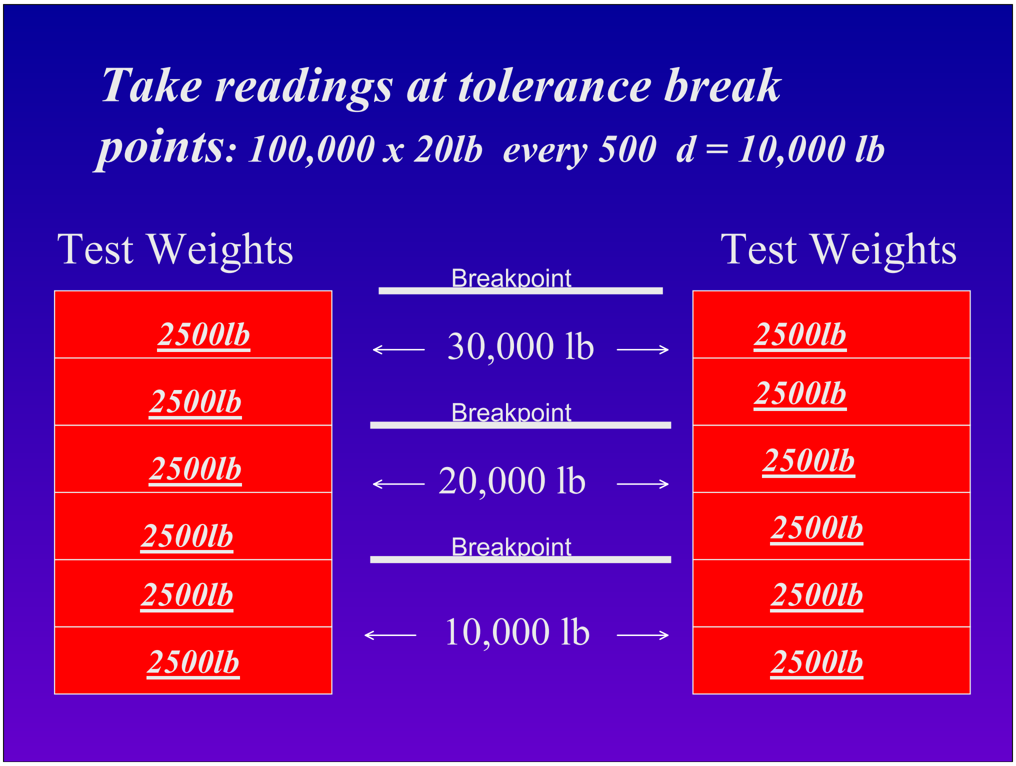


Explain how scale sections and load-bearing points are typically numbered in relation to the location of the indicator; when positioning oneself in front of an indicator, section 1 is to the left and the next adjacent section to the right is 2 and so forth. Load bearing point one is furthest away to the left and increases as you move in a clockwise direction as shown.

Preparation

- Position test equipment in a safe location.
- Apply needed error weights – weighbeams, digital scales (e.g., acceptance tolerance).

Explain the importance of properly and safely setting up test equipment in preparation of a test. Describe the procedure for using error weights to determine scale errors on a beam scale. Describe how error weights can be used to determine if one-half division acceptance tolerance has been exceeded when testing an electronic scale.

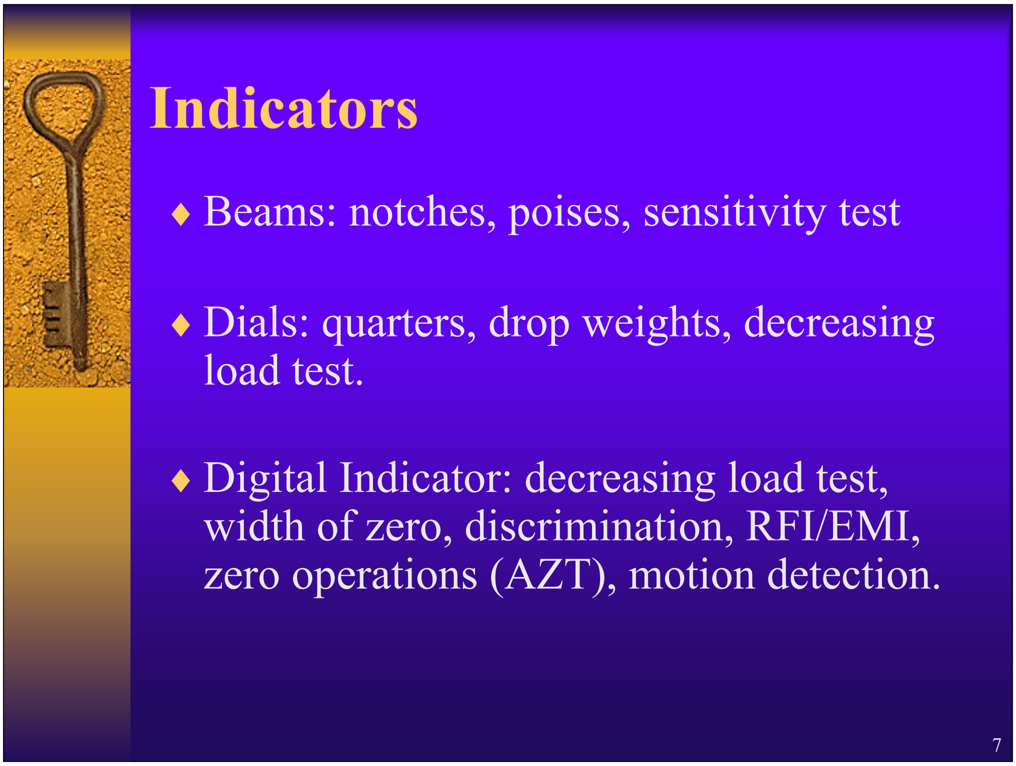


Define the term "tolerance break point" and explain why heavier capacity scales are sometimes only "read" at such points opposed to all points throughout the test.(expedience)

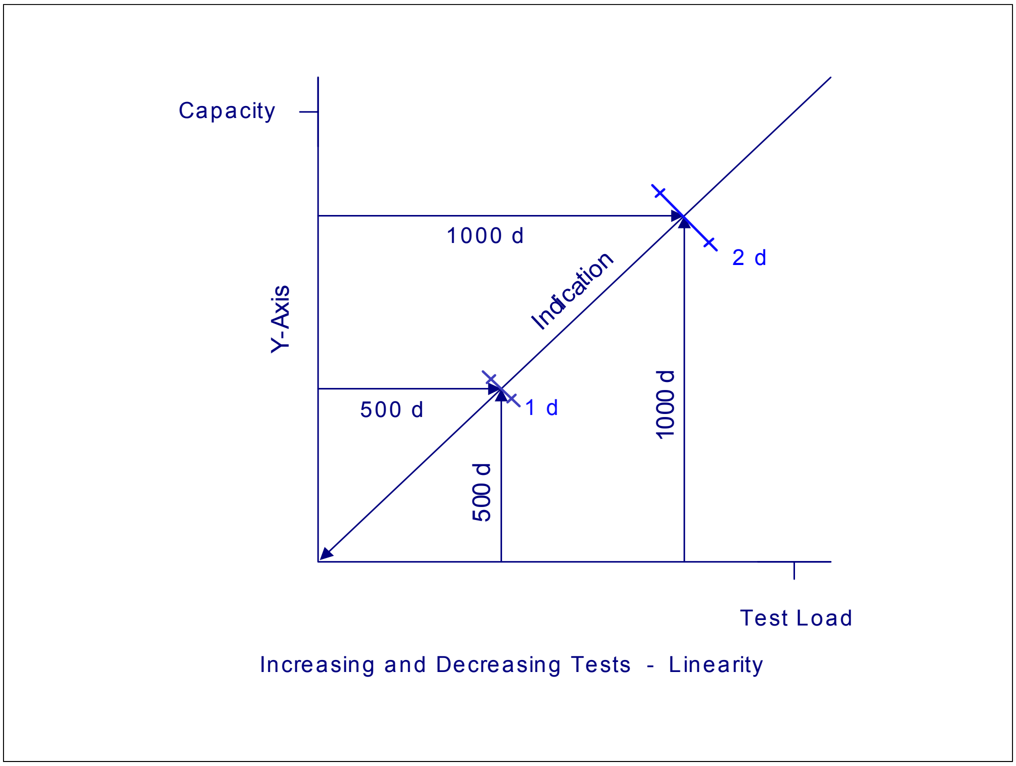
Indicators

- The type of indicator used will determine several of the tests to be conducted:
  - Beams (notches, multiple poises)
  - Dials (quarters are adjustable, tare bars)
  - Digital (electronic tests)
- Check T.N.5. Repeatability
- T.N.4.4. Agreement of Indications on Shift Tests

Describe the three indicator types, the tests that are required, and why such tests are necessary. Describe how indicators can be tested and calibrated apart from the load receiving element. Explain how scale errors observed in a test can be caused by either the weighing elements, indicating elements, or a combination of both.



Describe and explain each test for the appropriate indicator type.

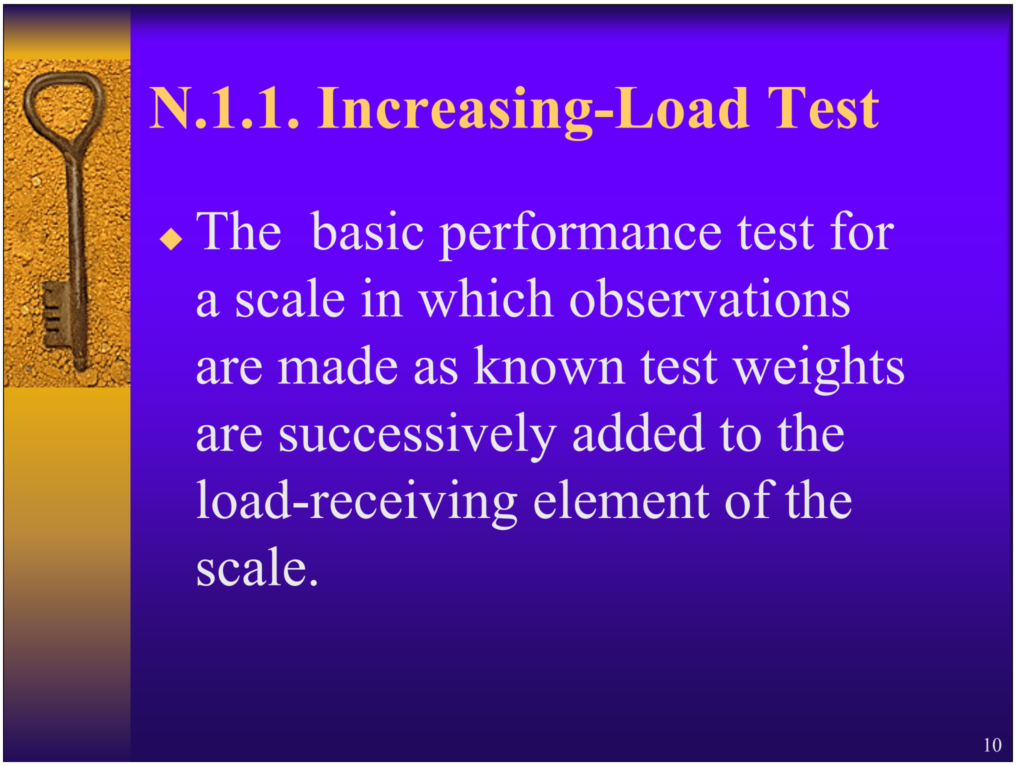


Explain why errors in a scale should be linear. Explain what this graph is showing. Provide possible causes of non-linearity in scale tests. (Some common causes of non-linearity are any of the following: defective load cell, frictional binding, severely worn pivots and bearings, worn notches in a weighbeam, etc.)

EPO Tests

- Zero
- Increasing Load Test
- Shift Test
- Decreasing Load Test (automatic scales only)
- Return to Zero
- Strain or Substitution
- Return to Zero

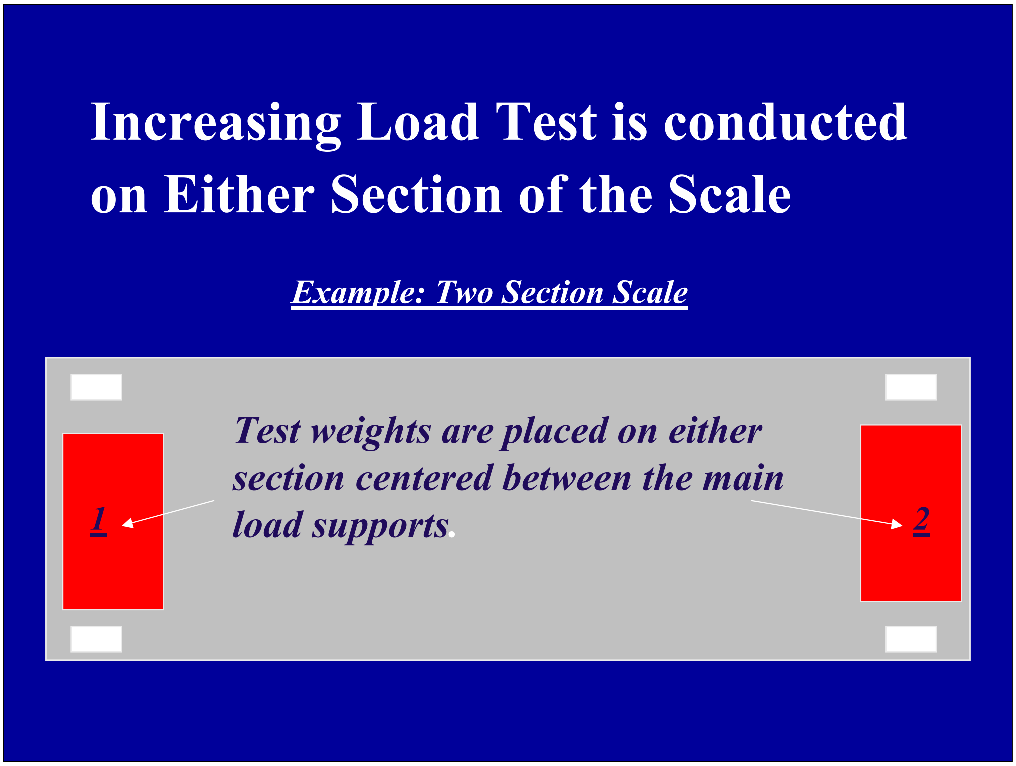
Explain how the EPO tests are arranged and why such tests are necessary.



Describe the procedures for conducting this test on vehicle and axle-load scales. Be sure to explain that this test can only be conducted by successively adding or building up of test weight onto the scale platform. It is the results obtained from this test that provide an easy determination of a scale's linearity. Explain how this is achieved.

N.1.9. Zero Test

Read and explain N.1.9.



Explain how the increasing load test is conducted. Be certain to emphasize that the test weights are to be centered directly over the main load supports or sections of the scale.

N.1.1. Increasing-Load Test

Photo of an increasing load test being conducted.

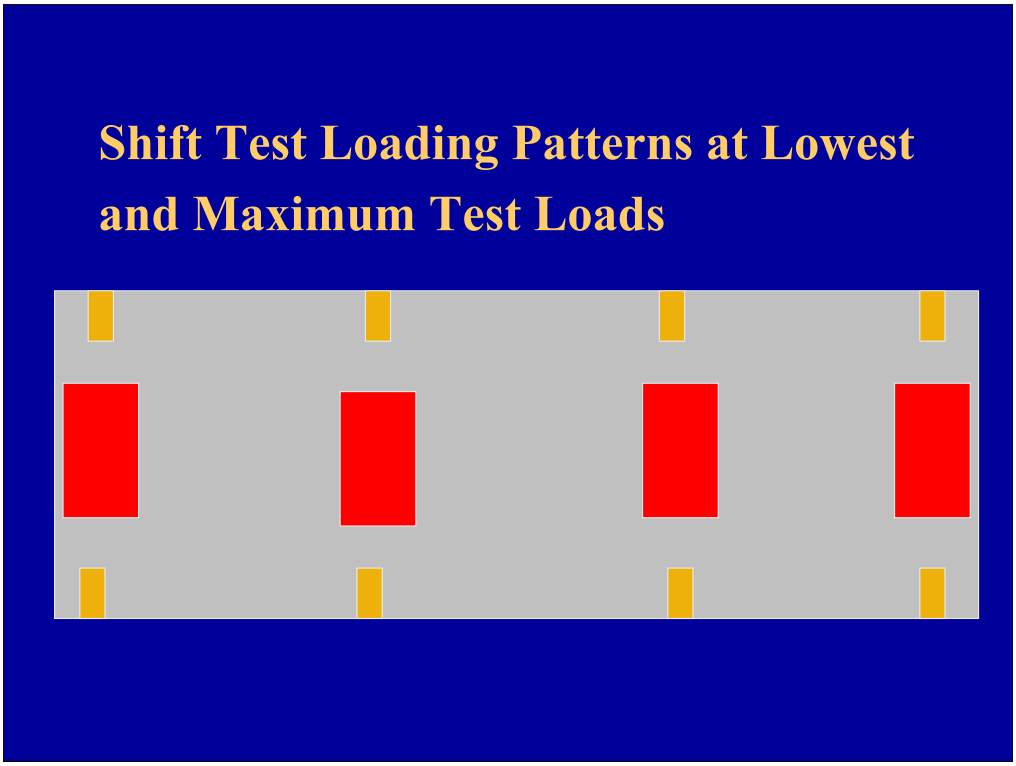
Photo of an increasing load test being conducted.

N.1.3.4. Shift Test Procedures

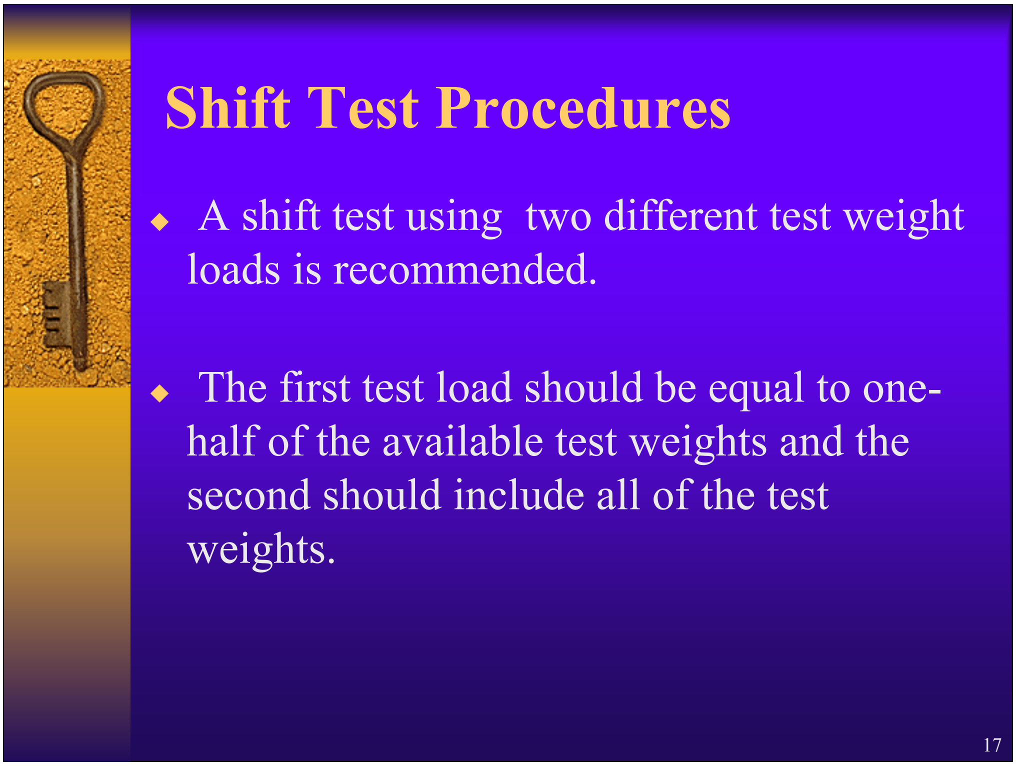
- At least one shift test must be conducted with a test load equal to at least 12.5% of scale capacity. Apply the test ***load*** anywhere on the load receiving element using prescribed test pattern and within maximum loads.

- Position the weights in the center of each section, equidistant between the main load supports.

This presentation provides instruction on conducting the shift test using two different shift test loads. Explain the benefit of using two different shift test loads opposed to one. Read N.1.3.4. and fully explain each of the four parts to this requirement. Explain the purpose of the shift test and what the results may tell about the condition of a scale.



Position of the test weights when performing a shift test at both lowest and maximum test loads.

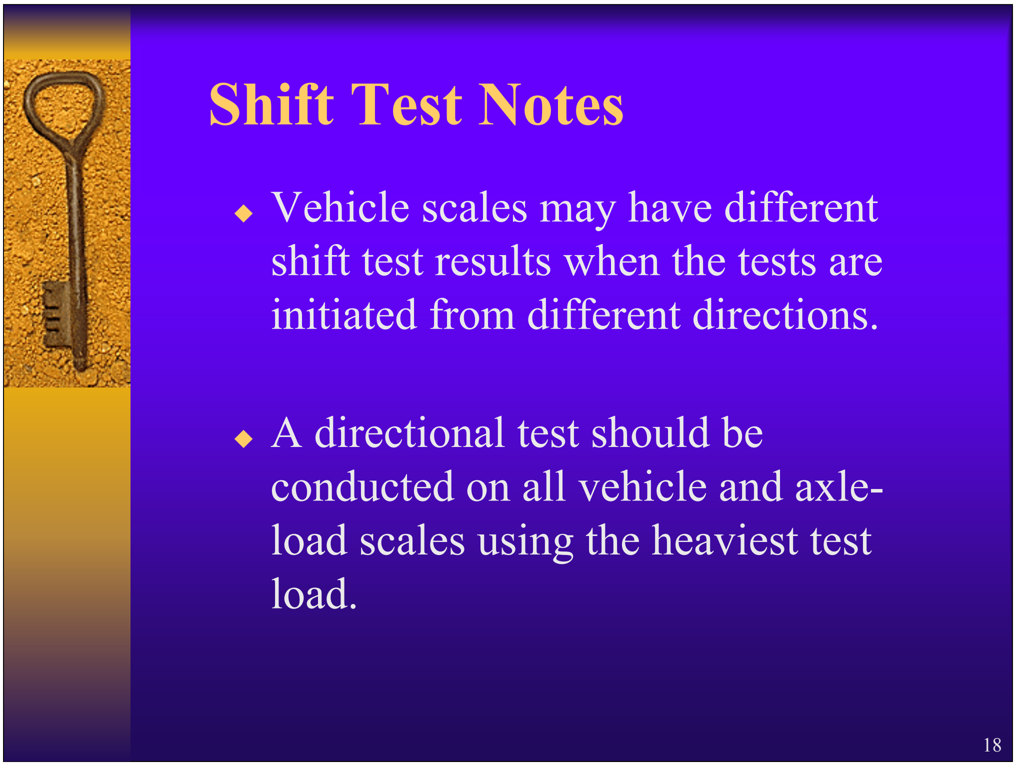


Describe how to determine the weights of the two shift test loads using the following criteria as a guide:

-The maximum shift test load shall be either the marked CLC or the total available test weights, whichever is least.

-The lower shift test load shall be one-half the maximum shift test load.

- A shift test load shall not be less than 12.5% of scale capacity.



Describe how the directional shift test is performed. This test should only be performed at the maximum shift test load.

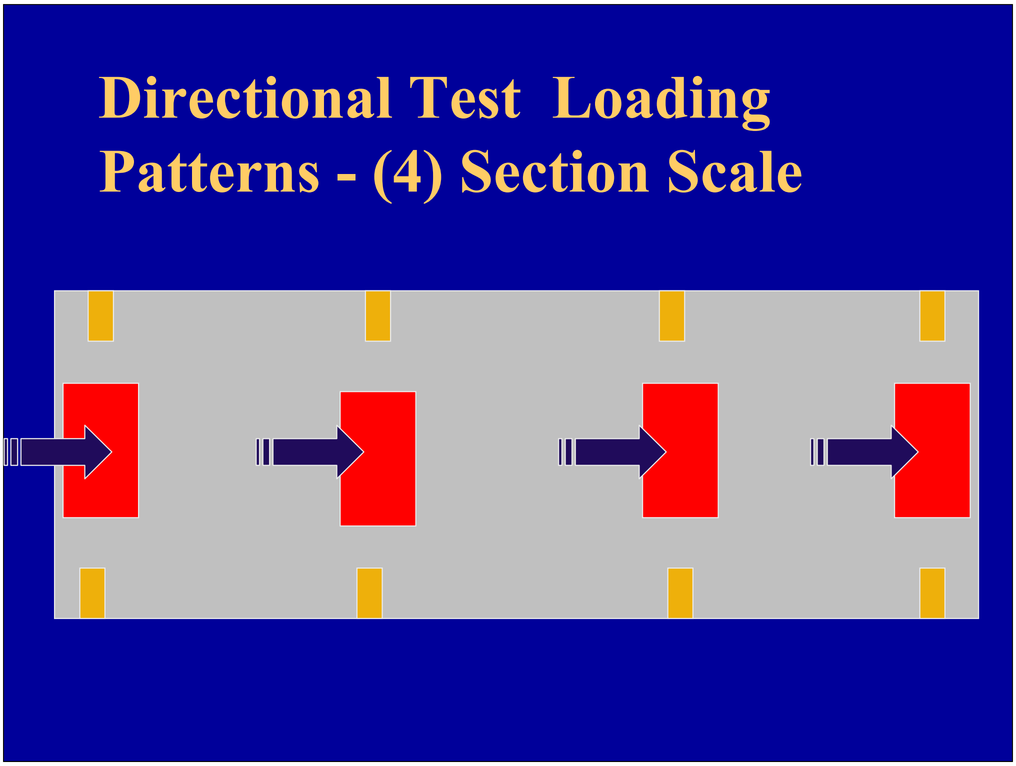


Diagram of the directional test showing the weight being moved from left to right.

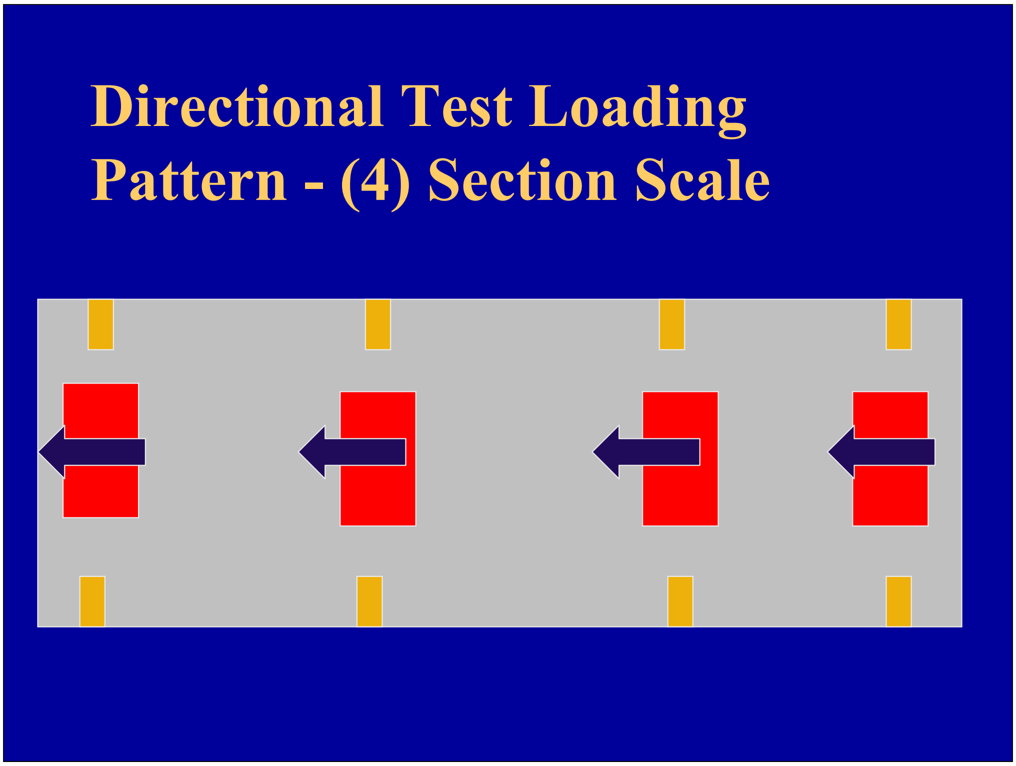


Diagram of the directional test showing the change in direction of movement.

Shift Test Notes

- Vehicle scales should also be tested off-center to verify the accuracy of individual load positions.
- When loading the scale be careful to conform to test patterns and maximum loading requirements.
- After completion of the shift tests, verify zero-load balance before starting any other test.

Explain the purpose of performing an off-center shift test; the test discloses improper calibration technique. Describe the locations of the test load during the test and be certain to include necessary loading precautions in your explanation as described in N.1.3.4. This test should also only be conducted at the maximum shift test load. Zero-load balance is checked whenever test weights are removed.

Note: The off-center shift test is an optional test.

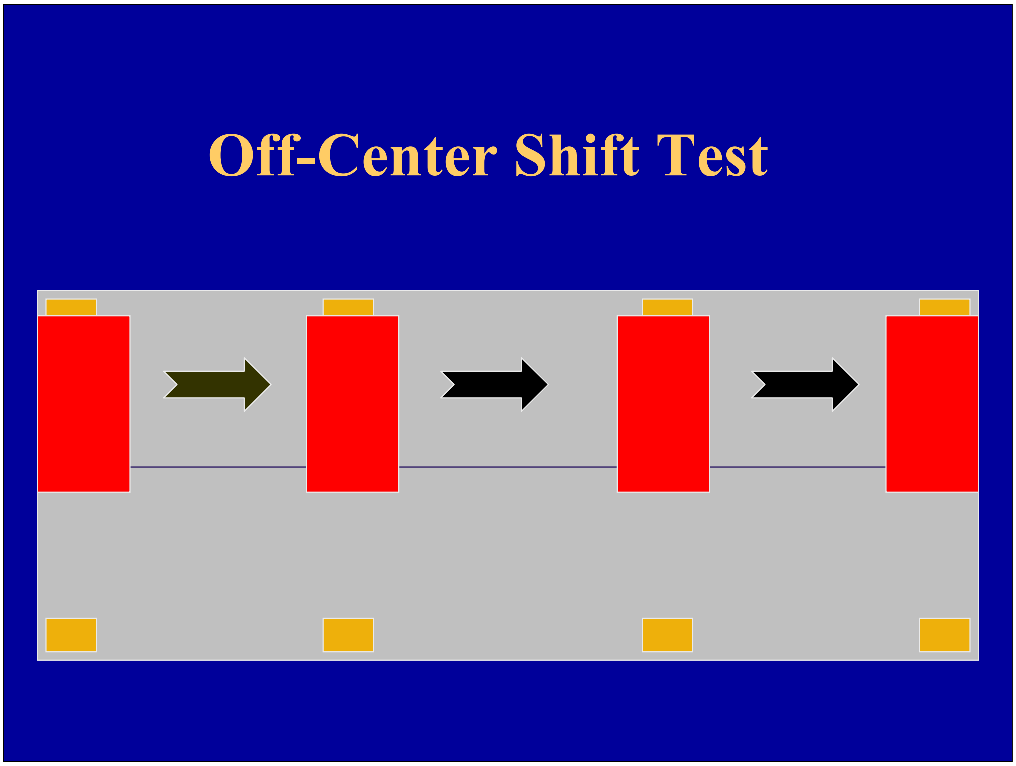


Diagram showing location of test weights. When conducting this test using a test cart, it is important to maintain the carts' position on any section so that the wheels, opposite on the axles, are always applying force in both longitudinal halves of the platform. The test pattern as shown is loaded equally and at no time should one side of the pattern be loaded to more than one-half the CLC or test load before loading the other side.

Note: The loading of both longitudinal halves of the platform as described is also necessary when off-center testing without the use of a test cart.

Reference: N.1.3.4.

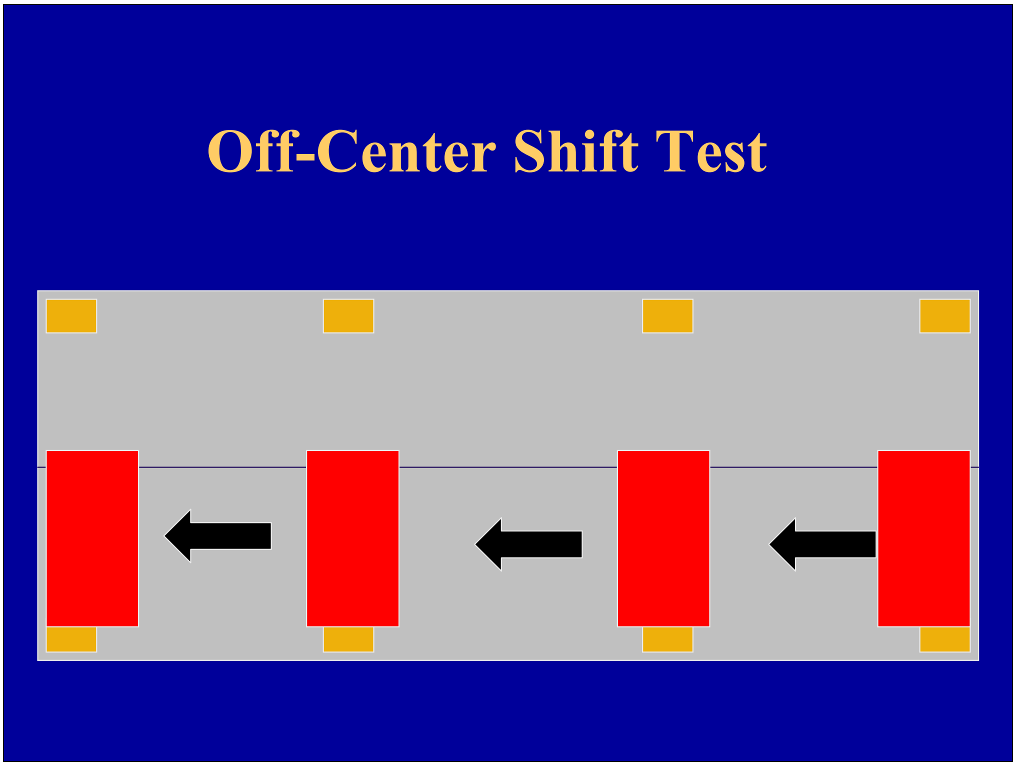


Diagram showing location of test weights. Same rules for loading apply here.

Shift Test Notes

- Midspan and directional tests are typically conducted at the higher of the two shift test loads.
- Midspans are located equidistance between any two adjacent sections.
- Loading at midspans may uncover deflection or other problems in the load receiving element.

Define deflection and describe the affects on the weighbridge and on the accuracy of a scale. Because deflection is most likely to occur at the higher test weights the midspan test is conducted only at the maximum shift test load.

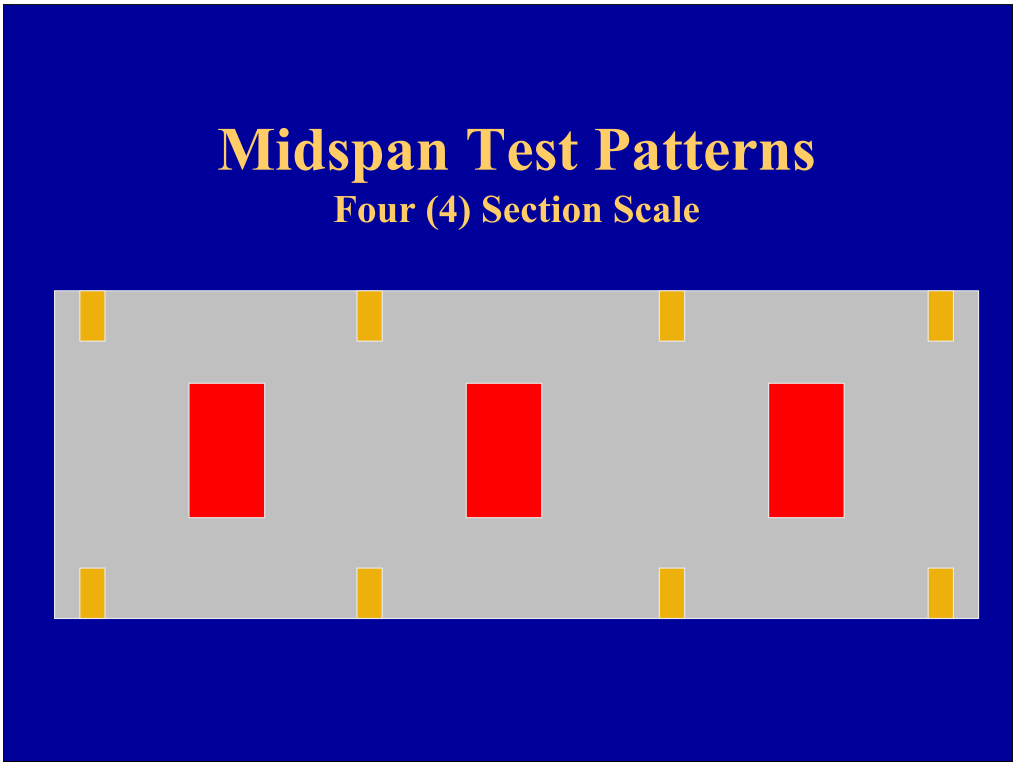


Diagram showing midspan test patterns.

N.1.3.4. Shift Test

Photograph of the shift test.

N.1.3.4. Shift Test

Photograph of the shift test.

N.1.3.4. Shift Test

Photograph of the shift test.

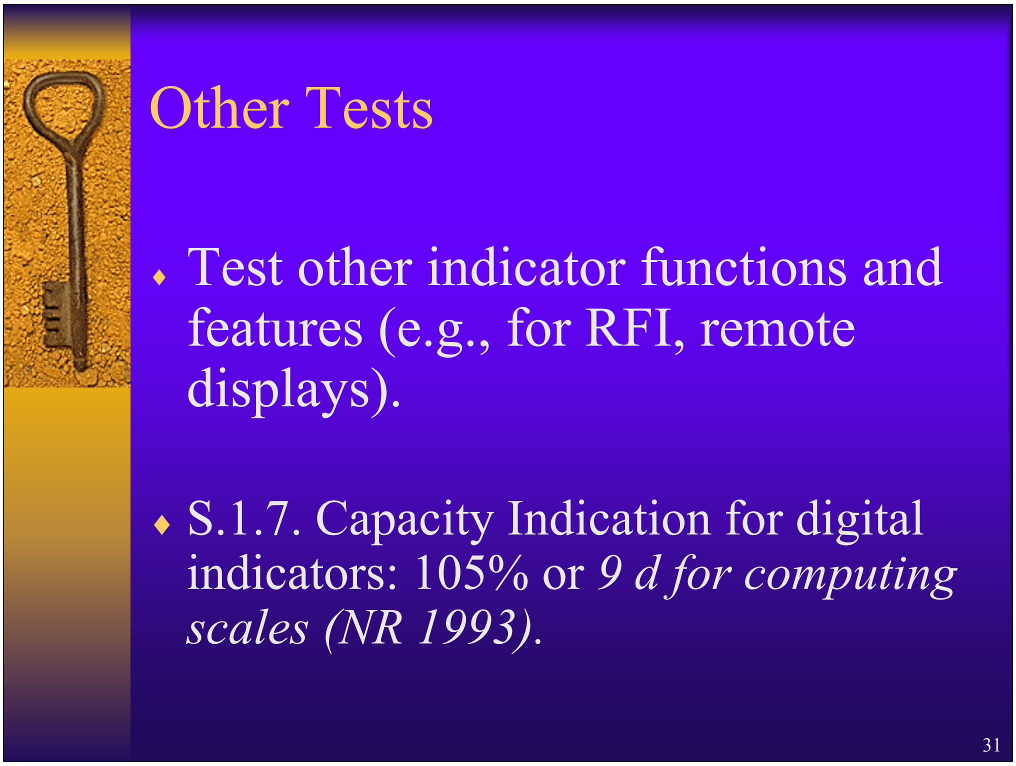
N.1.3.4. Shift Test

Photographs of the shift test.

N.1.2. Decreasing Load Test

- For automatic indicating scales only. The accuracy of the scale is tested as the load is reduced.
- Purpose of test – identify hysteresis, friction and other problems.
- Conducted at one-half maximum test load (but may be verified at any time test weights are removed.)

Define an automatic and non-automatic indicating scale. Describe the procedures for performing a decreasing load test. Explain the purpose of test. Explain hysteresis and describe its affect on a scale. (Hysteresis is the capability of metal to quickly return to its original form once it has been stressed or changed)



Explain the need for testing proper operation of all device features and controls, including switches, push buttons, keyboards, remote displays, etc. Describe the affects of RFI and EMI and explain how to conduct a test for these interferences. Read and explain S.1.7. (a) and (b).

N.1.9. Zero Load Balance Change

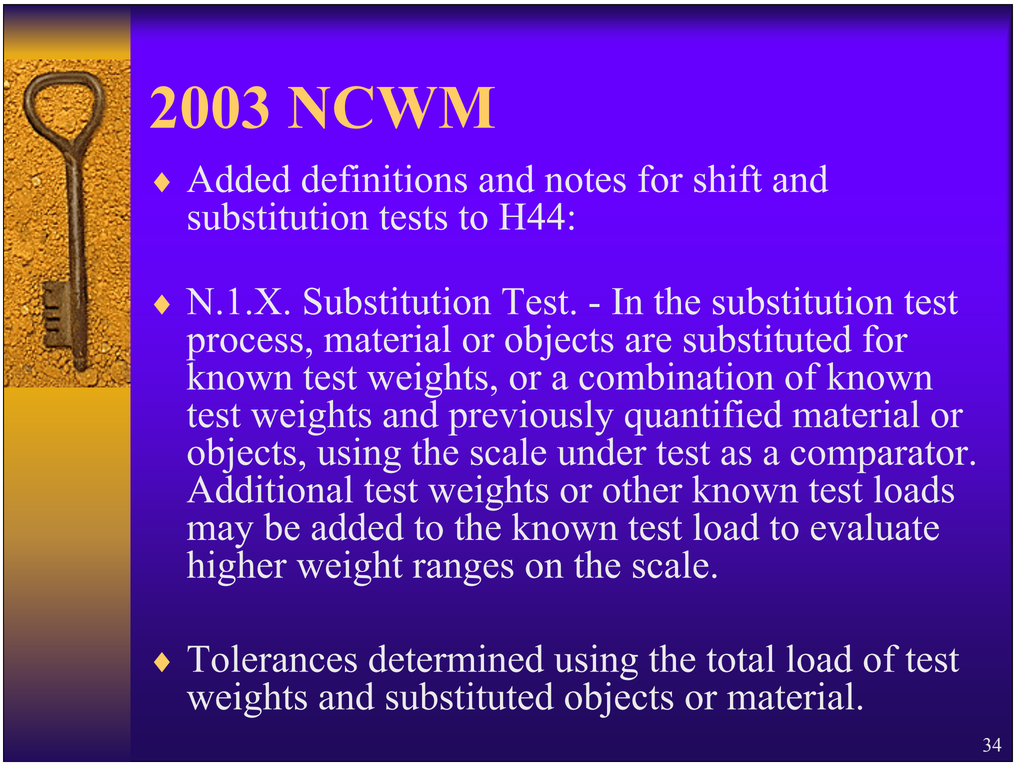
- A zero-load balance change test shall be conducted on all scales after the removal of any test load. The zero-load balance should not change by more than the minimum tolerance applicable. (Also see G-UR.4.2.)
- Table 6 – 0 to 500 d
  - Acceptance ½ d
  - Maintenance 1 d

Read and explain N.1.9 and G-UR.4.2. Describe some of the causes of zero balance change on vehicle and axle-load scales. Explain minimum tolerance and how a half division error is read on different types of vehicle scale indicators, including the digital type – (flashes between two divisions)

N.3. Table 4. Substitution & Strain Load Tests

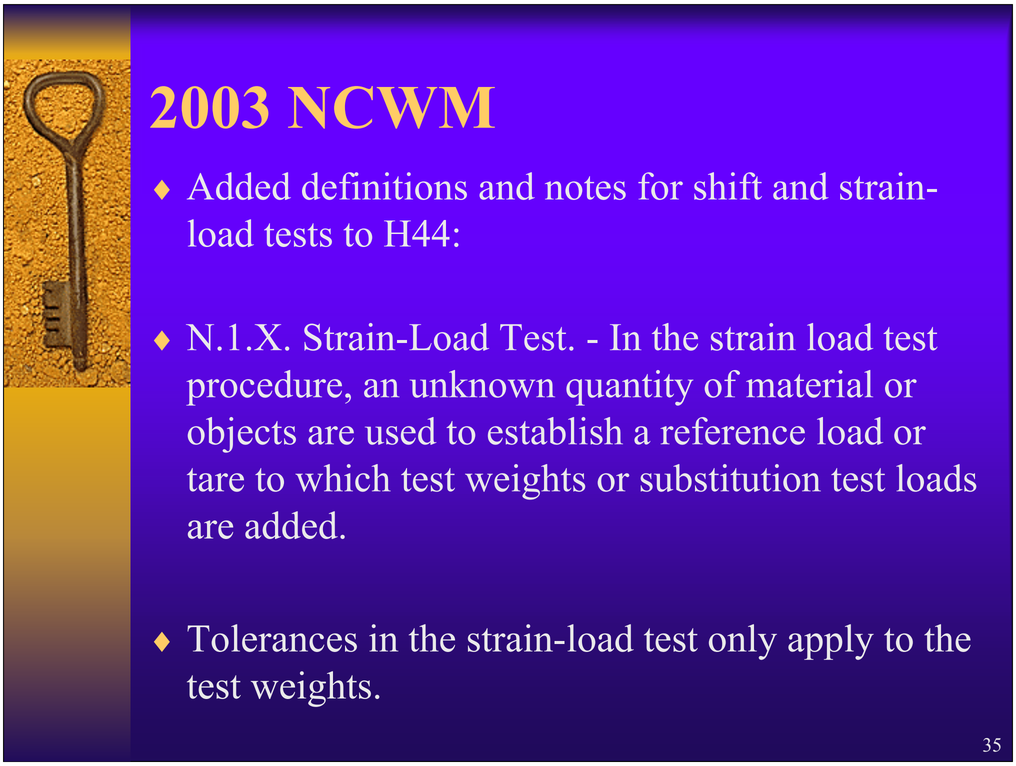
- How are they conducted?
- How are tolerances applied?
- Why does Table 4, footnote 2 limit the number of substitution tests to only 3?

Explain how the substitution and strain load test are conducted and describe similarities and differences. State the purpose of these two tests. (enables testing to a higher range on a vehicle scale, typically to used capacity) Explain each of the bulleted items. Explain the importance of starting both of these test at the center of a graduation and the procedure for locating the center of a graduation on a scale.



Explain this new definition being added to 2004 edition of H44. Describe how tolerances are applied to substitution tests.

Refer to handout entitled "2003 NCWM Changes to HB44."



Explain this new definition being added to 2004 edition of H44. Describe how tolerances are applied to strain-load tests.

Refer to handout entitled “2003 NCWM Changes to HB44.”

N.3. Strain Load Test

Photo of a strain load test.

N.3. Strain Load Test

Photo of a strain load test.

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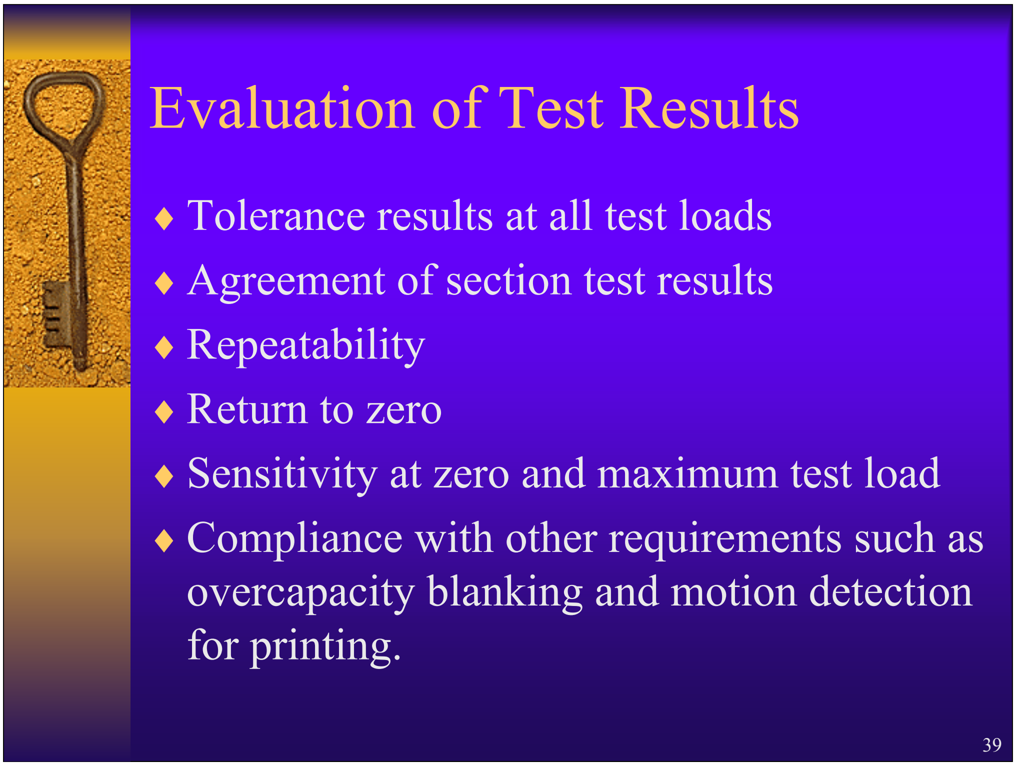
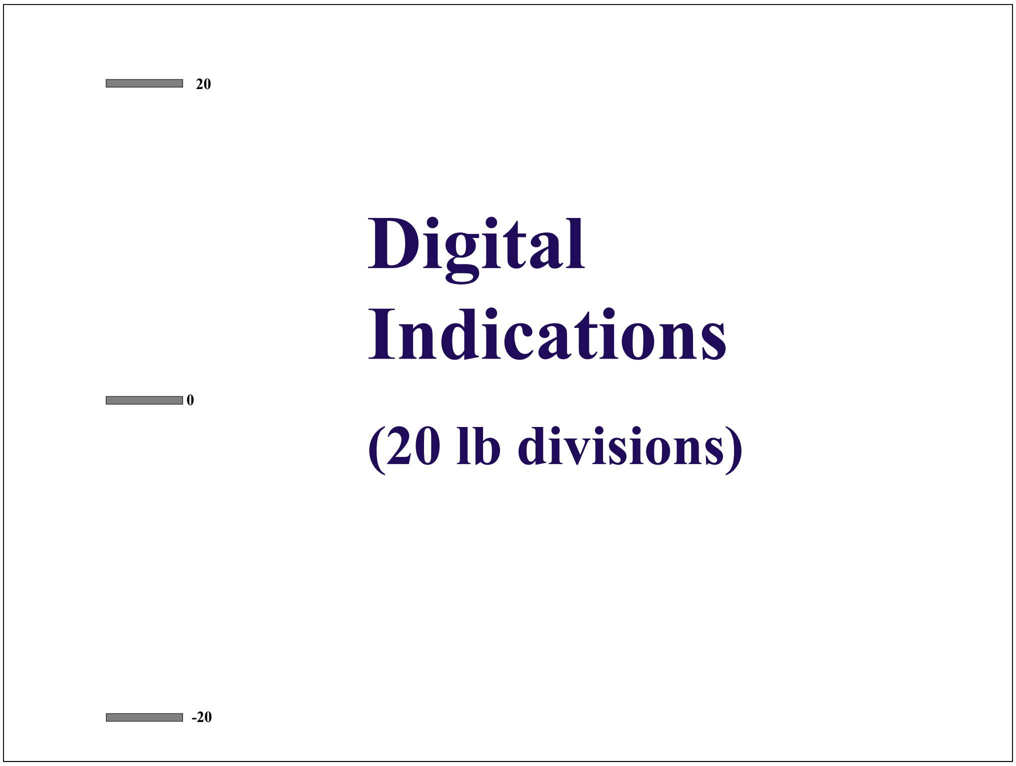
Photo of a strain load test.



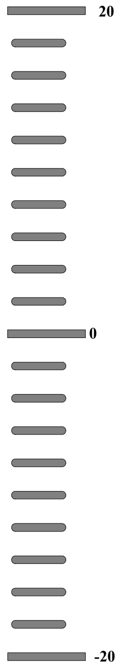
Explain each bulleted item and its association with the evaluation of a vehicle scale.

These are special test pertaining only to electronic instruments and covered in the next few proceeding slides.



Refer to the handout entitled “discrimination presentation.” This is the first page of the handout.

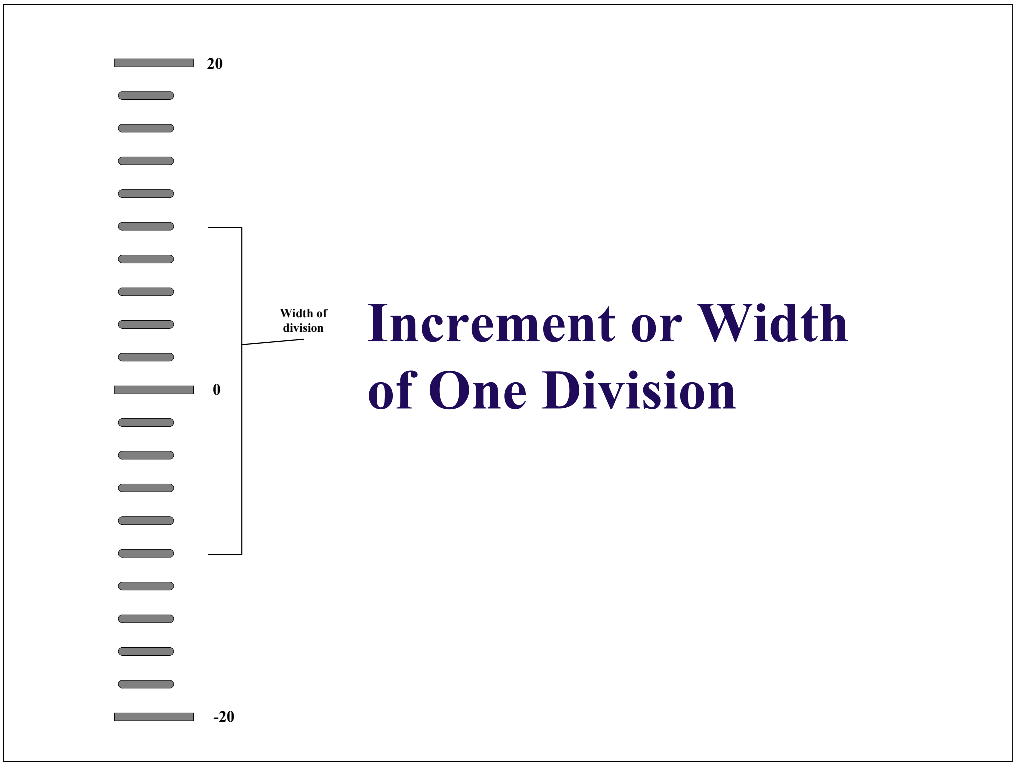
Digital Indications – what’s seen on a digital display having a 20 lb division size.



Subdividing Divisions into 10 Equal Parts.

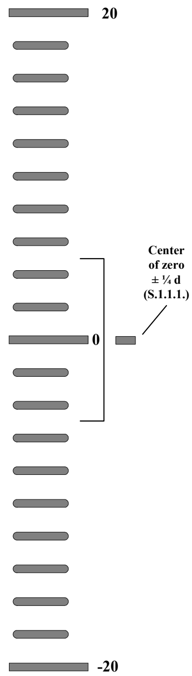
Refer to page 2 of handout entitled “discrimination presentation.”

Breaking down the same 20 lb division into 10 equal parts.



Refer to page 3 of handout entitled "discrimination presentation."

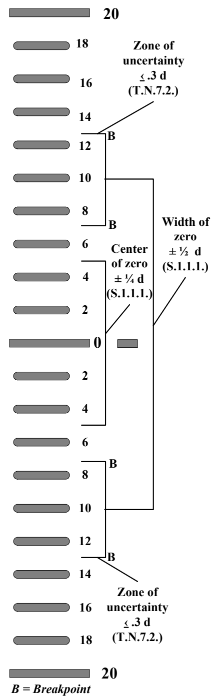
Describe the width of a division.



Center of Zero Requirement

Refer to page 4 of handout entitled “discrimination presentation.”

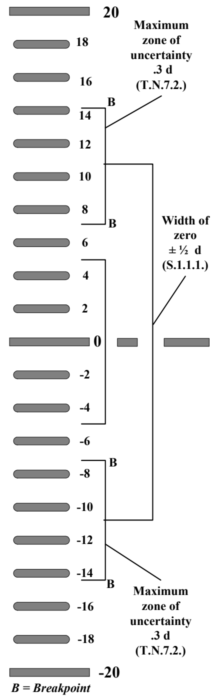
Explain the requirement S.1.1.1.



Zone of Uncertainty T.N.7.2.

Refer to page 5 handout entitled "discrimination presentation."

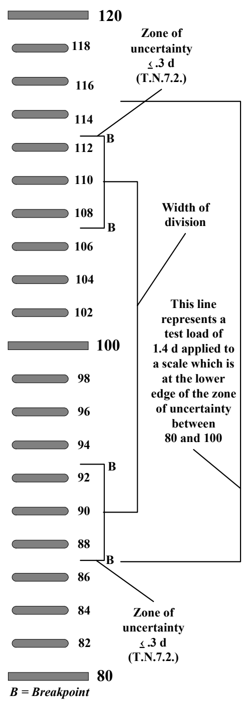
Read T.N.7.2. Explain the zone of uncertainty and describe how weight indications are affected when a scale enters the zone of uncertainty.



Why Test Discrimination?

Refer to page 6 of handout entitled “discrimination presentation.”

Explain the purpose of the discrimination test. Describe how scale indications are affected if the zone of uncertainty is set excessively wide. Describe the impact on accuracy and the stability of the weight display of the scale when the zone of uncertainty is excessively wide.



Test For Discrimination at Zero Load

a. With the device on zero, place 20 lb (ten – two pound weights) on the platform.

b. Zero the scale and place a load equal to 5 d (100 lb)on the platform.

c. Remove the smaller weights in 0.1 d (2 lb)increments until the indication flickers between 80 lb and 100 lb. The test is conducted just below the lower edge of the zone of uncertainty for increasing load test. (See N.1.5.1.) With the indication flickering, continue removing weights in 0.1 d increments until 80 lb becomes a steady display.

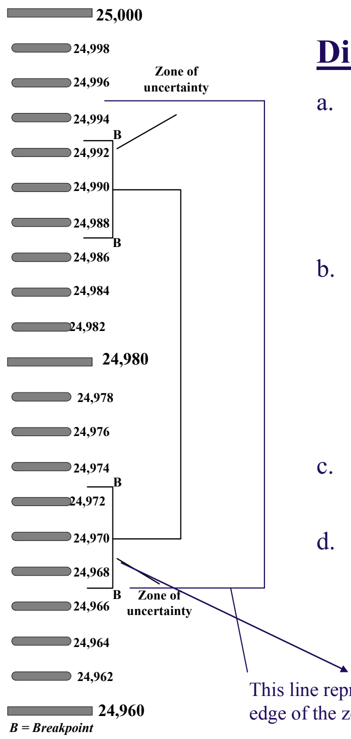
d. Add the test load equal to 1.4 d (28 lb) to the scale.

e. The indication should read a steady 120 lb.

f. If the scale passes this test at a load near zero, the test should be performed near maximum test load.

Refer to page 7 of handout entitled “discrimination presentation.”

Describe the procedure for testing discrimination at zero load. Explain why the test is started at 100 lbs (On scales with AZM, this mechanism would interfere with the test if started at zero or a near zero load condition) Describe the affects of wind on the discrimination test and explain why the test may be difficult to conduct on even light windy days.



Discrimination Test at Max Load

a. With the maximum load applied to the scale, (25,000 lb in the example) remove small weights in 0.1 d (2 lb)increments until you just reach the zone of uncertainty. Scale should flicker between 24,980 lb and 25,000 lb.

b. Add 0.1d (2 lb) to cause the reading to become stable just above the edge of the zone of uncertainty (see N.1.5.1.). Indication should read a steady 25,000 lb and be at the high edge of the zone of uncertainty between 24,980 lb and 25,000 lb

c. Remove the test load equal to 1.4 d (28 lb) from the scale.

d. The indication must change by at least 2 d (40 lb) or indicate 24,960 lb.

This line represents a test load of 1.4 d removed from a scale which at the upper edge of the zone of uncertainty between 24,980 lb and 25,000 lb.

Refer to page 8 of handout entitled “discrimination presentation.”

Describe the procedure for testing discrimination at maximum load.

Automatic Zero Mechanism (AZM) S.2.1.3.*

How would you test AZM on scales having the following division sizes:

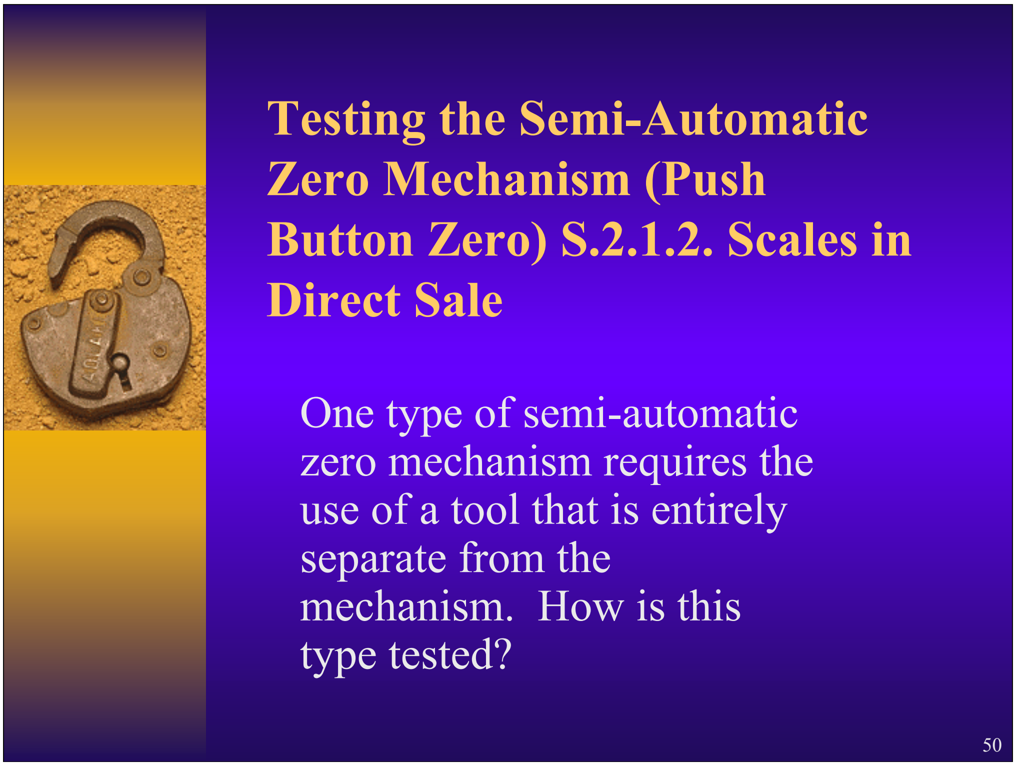
10 lb

20 lb

.01 ton

*Nonretroactive 1/1/81

Define the three types of zero setting mechanisms found on electronic vehicle scales. Read and explain S.2.1.3. Demonstrate how to determine if a scale has AZM and how to test for compliance of S.2.1.3. Have class answer all of the example questions above.



Read and explain S.2.1.2. being certain to define a direct sale in your explanation. Describe the differences between a push button, semi-automatic zero and a semi-auto zero setting mechanism that requires a tool separate from the device to re-zero the scale. Explain the test for the push button type of semi-automatic zero and how to determine compliance with S.2.1.2.

Testing the Semi-Automatic Zero Mechanism (Push Button Zero)

The second type is simply activated by pressing the zero button on the scale display. How is this type tested?

Describe the test and explain why the requirement pertains to this type and not the other.

S.2.5.1. Digital Indicating Element

- "Motion Detection" - recording elements can only print weight values when the indication is stable with 3 d and the values must be within applicable tolerance.
- How is this feature tested?

Explain the purpose of motion detection and describe how it works. Explain how to conduct the test on a simple digital indicator with a ticket printer. This requirement does **not** apply to recording elements attached to dials – provide explanation. Also, describe and explain how to conduct the test on complex scale installations that are interfaced with a computer (not built for purpose device) and ticket printer.

Special Features - How Are They Used?

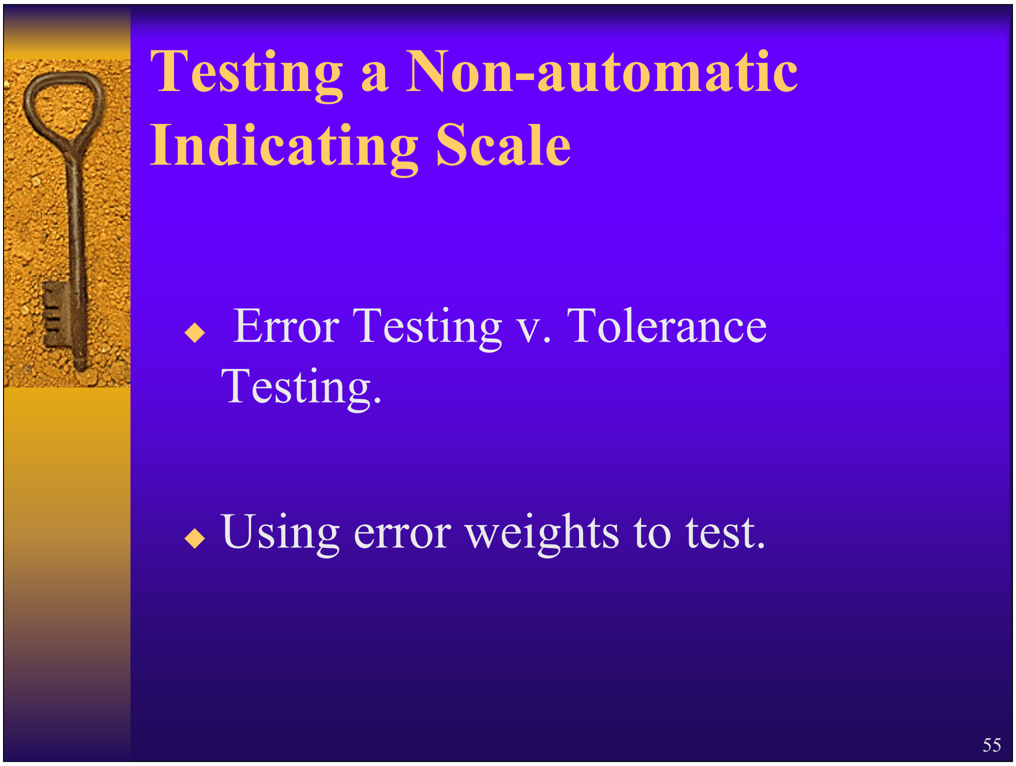
- Tare – keyboard, push button, stored, thumbwheel, tare auto-clear
- Gross, tare, net display
- AZM and semi-AZM
- Computers, ticket printers
- Auxiliary displays, scoreboards.

Review the special features that are found on vehicle scales from the list above. Describe how each is typically used and explain why requirements must also pertain to special features.

Additional Test Notes for Indicators

Dials, Weighbeams, and Digital Indicators

There are additional tests that are indicator specific which need to be performed.



Explain the use of error weights in determining scale errors on a scale with a beam type indicator. Explain why error weights should always be used to determine scale errors on a beam scale.

Error Testing

- Typically used on beam scales but can used on any automatic indicating scale.
- Small weights are used to determine the exact error in the scale at any test load.
- The exact errors are compared to applicable tolerances to determine performance compliance.

Describe how errors are determined on a beam scale using this method of testing. Explain how scale errors are then compared to the applicable tolerance.

Tolerance Testing

- Pass/fail tolerance test of the device.
- Does not define the exact amount of error in the scale.
- Takes less time.
- Less affected by environmental factors (wind).

Describe how errors are determined on a beam scale using this method of testing. Note the procedural differences in the error testing method.

Testing the Sensitivity of a Weighbeam

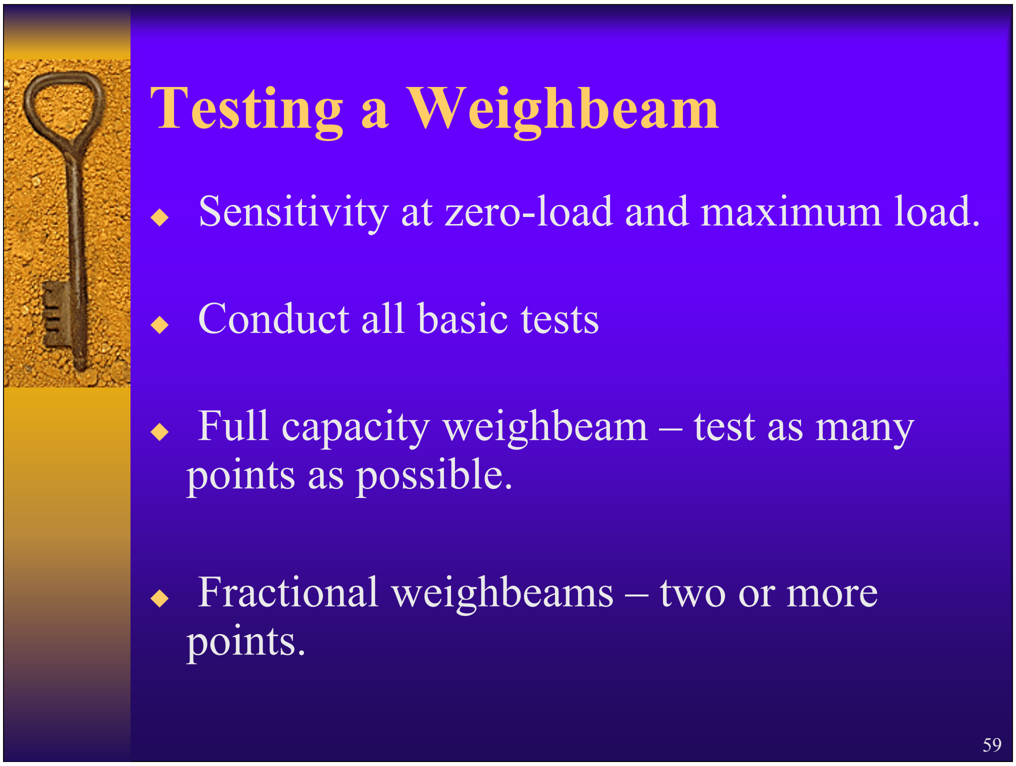
Marked - T.N.6.1.(a)

- Without a balance indicator – T.N.6.2.(a).
- With a balance indicator - T.N.6.2.(b).

Unmarked

- Without a balance indicator – T.2.7.2. and T.3.(a).
- With a balance indicator – T.2.7.1. and T.3.(c).

Explain weighbeam sensitivity and its importance in obtaining accurate weight indications on a beam scale. Explain how beam indicators are read when equipped with and without a balance indicator. Fully describe the procedure for testing sensitivity on a beam scale with a balance indicator and without one. Explain how each of the bulleted requirements above are applied and include in your explanation any differences in marked v. unmarked applications. Also, explain some of the causes of reduced sensitivity in a beam indicator used on a vehicle scale.



Describe the tests shown above and explain why they are important. Explain the term basic test (refer to EPO test on slide 9 of this chapter when explaining the term).

Testing a Weighbeam

- If equipped with a T/R beam, print ticket at several test loads.
- Remove all weights and loads and check zero-load balance.

Describe a T/R beam, how it functions, and why it is important to print tickets at several test loads. Explain the zero-load balance test. Describe how a T/R beam is designed to print the weight corresponding to the sum of the full capacity beam and the fractional beam.

Testing Dial Indicators

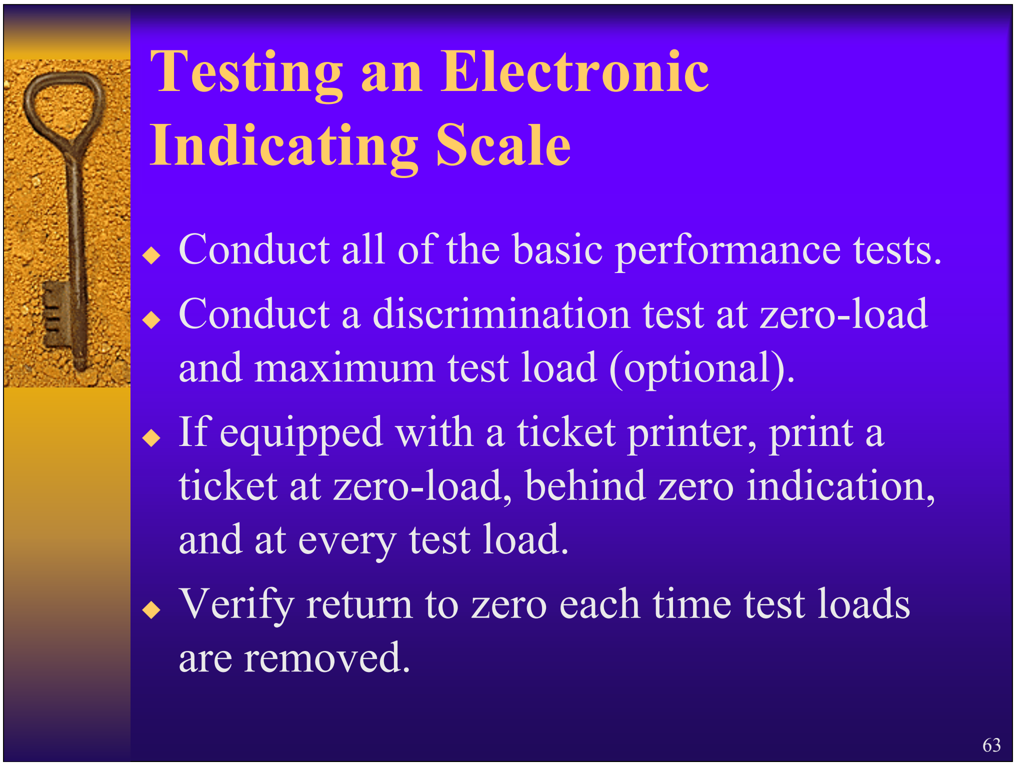
- Conduct all of the basic performance tests.
- Test at not less than 3 points on the reading-face, including all possible quarters of the reading-face capacity.
- Verify the accuracy of as many unit weights as possible.

Identify all performance tests – refer to slide 9 if needed. Explain why it is necessary to test quarters of reading face capacity and as many unit weights as possible.

Testing a Dial Indicator

- If equipped with tare bars test at not less than two points on each bar (typically one-half and full capacity).
- If equipped with a ticket printer, print ticket at zero-load, behind zero indication, and at each test load.
- Verify return to zero whenever test loads are removed.

Explain how tare bars are used on a dial scale and why it is important to test them at multiple points. Explain the why the middle and bottom bulleted points are also important. Describe the permissible recordings of a ticket printer attached to a dial indicator when the indicator is in the following positions: behind the zero graduation, directly in coincidence with zero graduation, exactly between two graduations, and between two graduations but closer to one than the other.

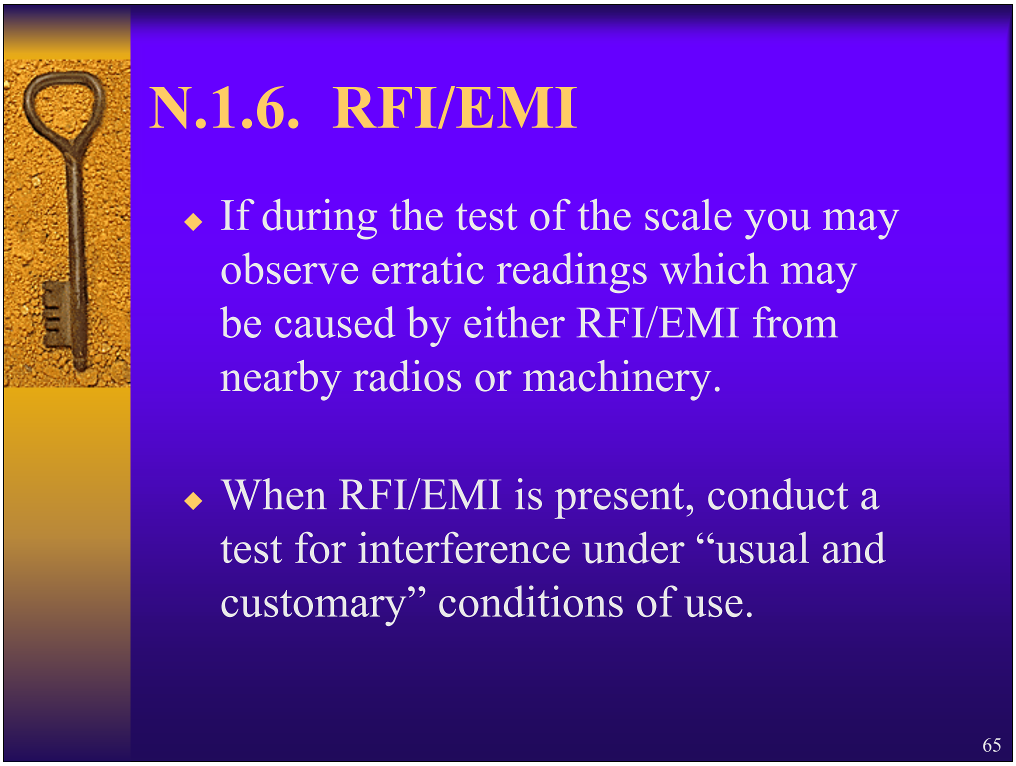


Again identify all performance tests – refer to slide 9 if needed. Review the remaining bulleted points.

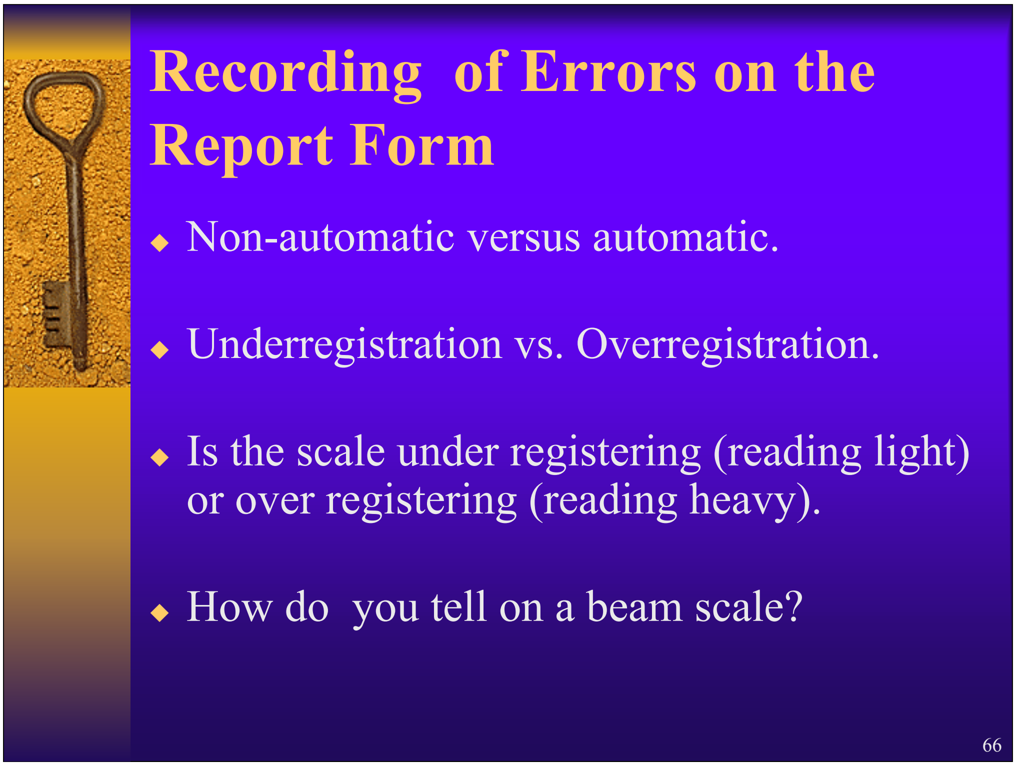
Testing an Electronic Indicating Scale

- Verify that any tare feature operates only in a backward direction with respect to zero and that all displayed weight values are properly identified.
- If equipped with both a tare feature and ticket printer, make certain printed indications are accurate and properly identified.

Discuss the importance of determining how all operational controls function on each device inspected. Describe the different types of tare features found on vehicle scales and explain how each must function to comply with existing requirements. Describe how digital displays and ticket printers should function when the scale is indicating a zero balance condition and when the scale is indicating a back of zero condition. Also explain how recorded values on printed tickets must be identified, i.e. gross, tare, net, pounds, tons, kilograms, etc.



Identify the observable affects of RFI and EMI on an electronic scale. Discuss the magnitude of error that can be achieved when digital indications and their associated recorded representations are affected by RFI and/or EMI. Explain the procedure for testing RFI and provide guidelines of when the test should be conducted. Explain the procedure used in an attempt to find a specific cause of EMI.(process of elimination is typically used)



Explain that the recording of errors on a report form is accomplished differently for non-automatic v. automatic indicating scales. Define the terms underregistration and overregistration and how the terms are applied to the errors associated with an automatic and non-automatic scale.

Non-automatic Indicating Method of Recording Errors

Load Position	Test Weights*	Scale Indication	Error
Section 1	4985lbs	5000 lbs	+ 15 lbs
Section 1	9970lbs	10,000 lbs	+ 30 lbs
Section 2	9985lbs	10,000 lbs	+ 15 lbs
Section 3	9990lbs	10,000 lbs	+ 10 lbs
Section 4	10,005lbs	10,000 lbs	-5 lbs
Balance	0		OK

* Indicates amount after removing or adding error weights.

This mock report documents the test results of a non-automatic indicating scale. Explain the entries shown under each titled column on this form. Explain how errors are determined using error weights (either tolerance or error testing) and how those results are recorded on a report form. Explain how it is determined if errors observed in the test of a beam scale are plus or minus. Read T.N.4.4. and then explain why it is necessary to use error weights to determine the exact error of each section on a shift test even when utilizing tolerance testing as the procedure to perform other performance tests on a beam scale.(It is not appropriate to apply the range requirements of T.N.4.4. to results obtained in the tolerance testing method. Always apply the error test method on shift tests and apply the range requirements of T.N.4.4.to those results)

Automatic Indicating Method of Recording Errors

Load Position	Test Weights	Scale Indication	Error
Section 1	5000lbs	5010 lbs	+ 10 lbs
Section 1	10,000lbs	10,030 lbs	+ 30 lbs
Section 2	10,000lbs	10,020 lbs	+ 20 lbs
Section 3	10,000lbs	10,010 lbs	+ 10 lbs
Section 4	10,000lbs	9990 lbs	-10 lbs
Balance	0	0	OK

This mock report form also documents test results. Explain the entries shown under each titled column on this report form. Explain how entries for an automatic indicating scale differ from those of an non-automatic indicating type. Assuming this scale has a 10 lb division size, discuss how individual section errors exceed maintenance tolerance and the range in errors on the section test exceed the absolute value of maintenance tolerance.