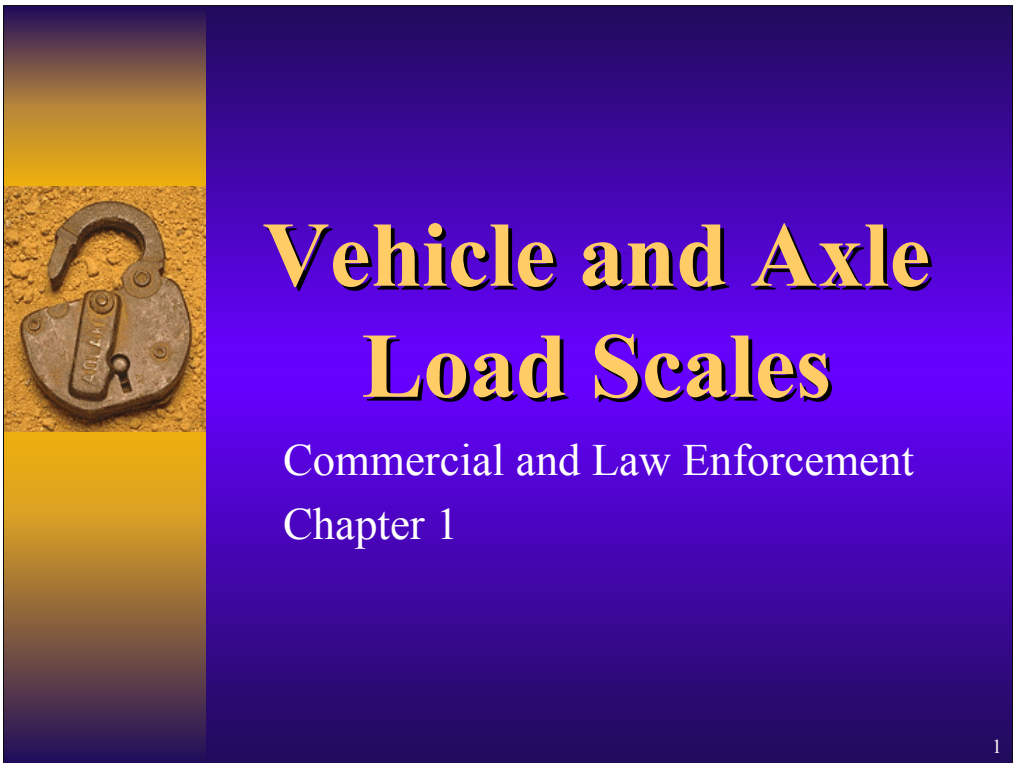


Purpose of Chapter 1

-Provide a description of the basic design, construction, and use of mechanical weighbeam scales, mechanical dial scales, and electronic digital indicator scales used in weighing vehicle and axle-loads.

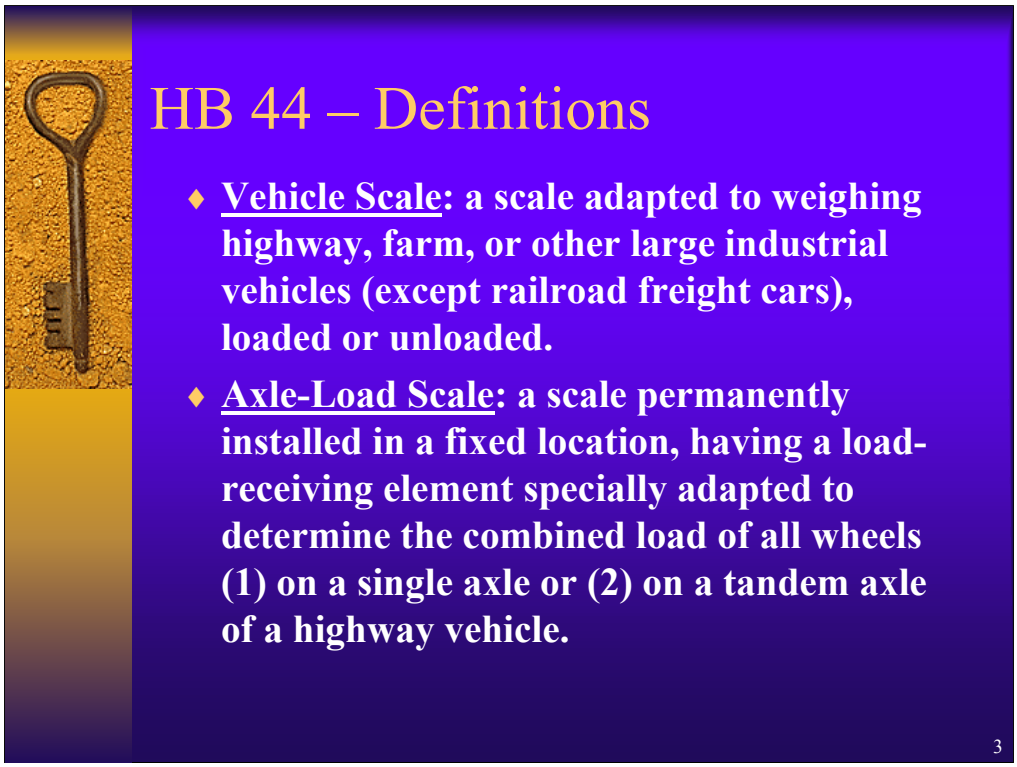
- Identify and describe the use of various vehicle and axle-load scale components and describe some of the special features of the scales.

- Describe procedures for legal entry into commercial establishments by weights and measures officials for the purpose of device examination.

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.

Define commercial application and provide examples of vehicle scales used in various commercial settings. Describe how law enforcement officials use axle-load scales and how this differs from commercial use (e.g., Commercial use is using a device for buying, selling, hire or award. Law enforcement use is using a device for enforcement of highway laws and for establishing statistical information.)

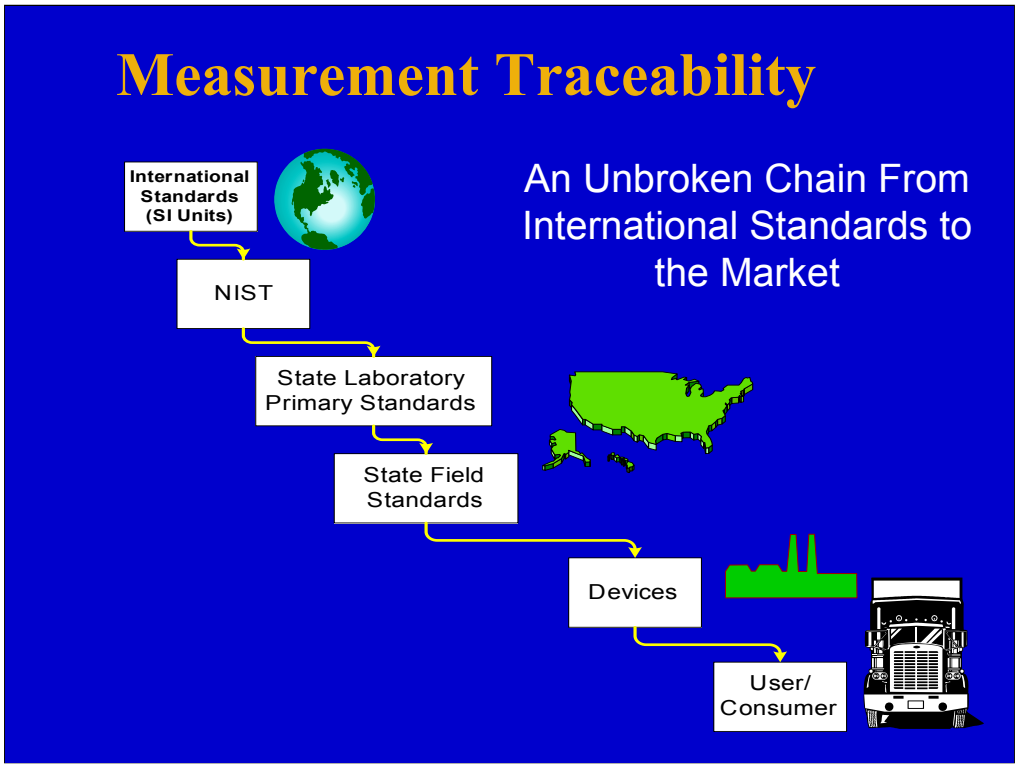
Read G-A.1., G-A.2., A.1., and A.2. and explain how commercial and law enforcement scales fit the application requirements.



Review definitions and explain the differences in the two scale types.

Explain how H-44 does not prohibit the use of axle-load scales in commercial applications, (i.e., charging truck drivers for obtaining axle weights), however, it does require vehicles to be commercially weighed only as a single draft. (See UR.3.3.) Also, explain why highway-law-enforcement scales are exempt from UR.3.3.

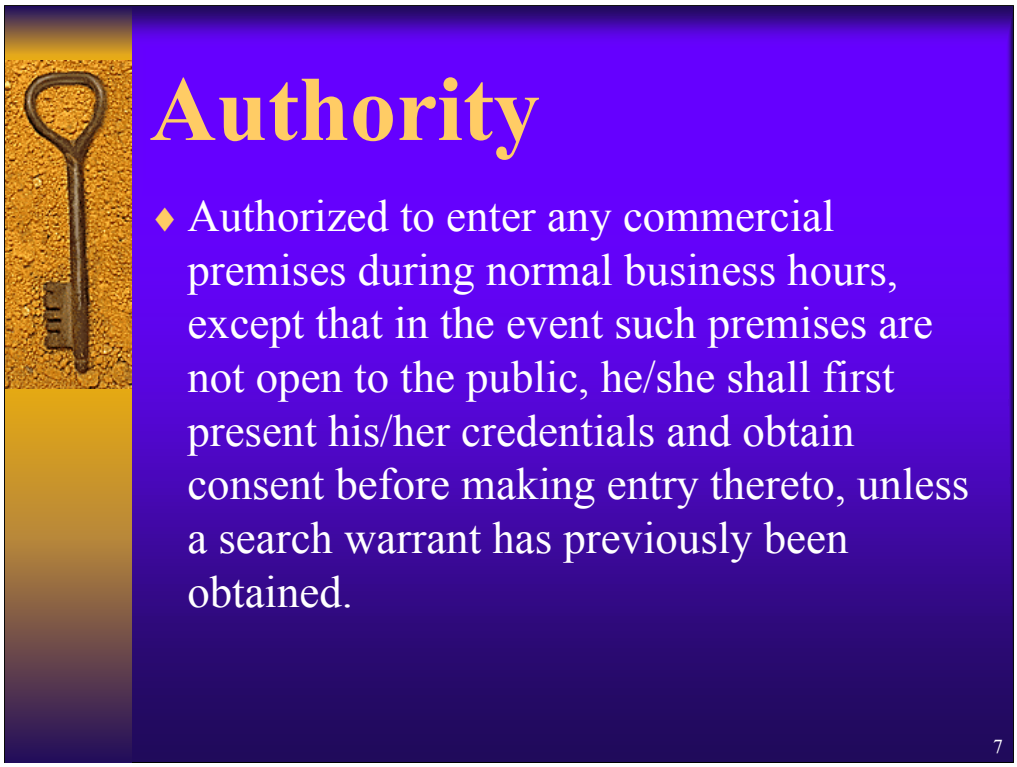
Explain the purpose and importance of weights and measures programs in the U.S. Discuss the possible negative effects on commerce if these programs didn't exist or if they existed but function poorly.



Explain how every piece of the chain must be in place:

- calibrated laboratory and field standards
- documented procedures for maintenance and use
- staff trained in test methods
- devices suitable and accurate for use
- systems in place to respond to and protect the user in business and consumers

Explain how weights and measures officials receive their authority. Explain the difference between the authority to perform inspections versus jurisdictional policies regarding inspection frequency and enforcement action.



Explain the importance of the following actions performed by weights and measures officials:

•conducting inspections during normal business hours;

• presenting credentials and obtaining consent;

• limiting inspections specifically to pertinent areas of the premises where devices are located.

Cardinal Scale

Location: Scale is installed at an aggregate business location.

Application: Sales of stone products, freight charges, and payment of drivers for delivery. If the property is leased, the owner may be paid royalties based on the amount of natural resources removed from the site.

Components: This is a fully electronic, metal deck, low profile vehicle scale, probably 10 x 70 ft. platform. It appears that scale deck is of such dimension to accommodate all legal road vehicles. Single truck scale installation normally necessitates weighing each truck in and out (tare and gross) to determine net weight by subtraction. Notice there is no concrete poured between the foundation piers making clean-out a bit difficult. The scale house has windows allowing for visual communication between truckers and scale operator.

Location: Weigh In and Weigh Out vehicle scales at an aggregate business.

Application: Sales of stone products and freight charges.

Components: Fully electronic, low profile, concrete platform, vehicle scales. Appears to be as many as 8 sections (8 pairs of load cell supporting concrete piers) on the scale to the left. Notice the use of guide rails mounted alongside the platforms to guide drivers on and off the platform. Traffic signal has been installed to signal drivers using the scales. Usually when two truck scales are installed in the same plant, one is used to weigh inbound (empty weight) trucks and the other is used to weigh outbound (loaded) trucks. The indicators from both scales are typically wired to a single computer which provides for the sharing of information between the two scales. Each scale is tested individually and there is no requirement in NIST HB-44 that requires the accuracies of the two scales to agree.

Fairbanks Scale

Location: Scale is being used in a logging operation.

Application: Sales of lumber (pulp operation), freight, establishing legal or safe load limits.

Components: Vehicle scale containing a pit, concrete pit walls and deck. Could be either mechanical or digital weighing elements.

Cardinal Scale

Location and Application: Typical vehicle scale installation possibly used in any number of commercial applications.

Components: Full electronic, above ground, metal platform, four section vehicle scale. Notice that there is no concrete poured between the piers of the foundation making cleaning underneath somewhat difficult.

Location: Axle-load scale used by a private shipper to load trucks to within legal axle load limits. Note: When using axle-load scales, private shippers and truckers often sum truck axle weights to obtain estimated total gross weights which are then used as comparisons to legal gross weight limits. Although this practice can be used for estimations, results obtained by split weighing should not be considered reliable and is prohibited for commercial weighing.

Application: Scale used to weigh single and tandem vehicle axles.

Components: Full electronic, two section, concrete platform, axle-load scale. Notice straight paved approach that is in the same plane as the platform and of sufficient length to insure the level positioning of vehicles. (See UR.2.6.2.) Also, notice the curbing and steel barrier that is used to keep vehicles from driving off the scale.

Fairbanks Scale

Location: Government owned property adjacent to interstate or major state highway.

Application: Truck weight enforcement.

Components: Multi-platforms (usually 3) with independent weighing capabilities utilizing separate indicators for each platform and a single totalizer indicator to sum them. The concrete platforms are installed in a pit. Photo shows tractor steering axle positioned on one platform, tractor tandem drive axles positioned on a second platform, and one assumes trailer tandem axles are positioned on a third platform. Photo also displays what appears to be a dead space between the first two platforms, evidenced by a small section of concrete located just forward of the tractor tandems.

Location: Photo taken from the load-receiving element facing the scale house and the indicating elements.

Application: Scale is being used to charge a fee for usage as evidenced by the posted sign. Oftentimes, owners of vehicle scales will open them to the public and charge a fee to weigh. That is probably the case here.

Components: A beam and digital indicator are visible through the windows of the scale house. These windows provide direct visual communication between someone located at the indicating element and someone located on the platform.(required by G-UR.2.2.)

Weigh-Tronix Scale

Location: Scale is installed at a truck stop along an interstate or major highway.

Application: Fees are customarily charged for usage. These scales are very useful because they typically provide individual printed recordings of axle weights as well as total vehicle weight. (see design of platforms below) Truckers often prefer there use because of this unique capability. Weights are also commonly used for establishing freight and moving charges.

Components: These are multiple platform scales and the platforms are used individually and in combination to provide individual axle weights, tandem axle weights, and total gross weights on vehicles. Photo shows concrete and steel modular type platforms (3 in all) which are being used simultaneously to weigh single axle, tandem axles, and total gross weight. Scale has a complete concrete foundation for easy cleaning. The signaling/communication device shown in this photo was installed to provide a means of direct communication between an individual located at the primary indicating or recording element and an individual located at the weighing element as required by G-UR.2.2.

Types of Vehicle Scales

This is a pit type installation of a vehicle scale. Notice how the approach that is visible and adjacent to load receiving element has been installed, (i.e., not less than 10 ft to be constructed of concrete or similar durable material to ensure this portion remains smooth, level, and in the same plane as the platform; reference: UR.2.6.)

This is a self service, low profile vehicle scale - drivers obtain the weights of their own loads. Notice the indicator and printer, (left side of the photo), that were installed for self service use. This traffic signal alerts users that the scale is on zero and ready to receive the next load.

This fully electronic low profile scale is said to be over 100 feet in length. There are no poured concrete piers required when installing this vehicle scale. It is designed to be placed directly onto compacted fill as shown in the photo. Notice how junction box, load cell covers and conduit have been securely mounted to the exterior of the load-receiving element.

Fairbanks Scale

This low profile scale has been installed under a loading rack and is being used to weigh liquid chemicals. Because liquids are sold by volume, the weights from this scale will need to be converted to a suitable unit of measure by dividing the density of the product into the weight. Sites that handle hazardous chemicals inherently create additional potential safety hazards for officials. These hazards may range in danger to those that are considered minor to those that are life threatening. Some of the potential hazards associated with such sites are spills of toxic chemicals, chemical fires or explosions, overhead clearance of dispensing equipment, etc. Officials should always report to proper management personnel when first entering a business and seek to determine the safety equipment needed and the procedures to be followed while working at any site.

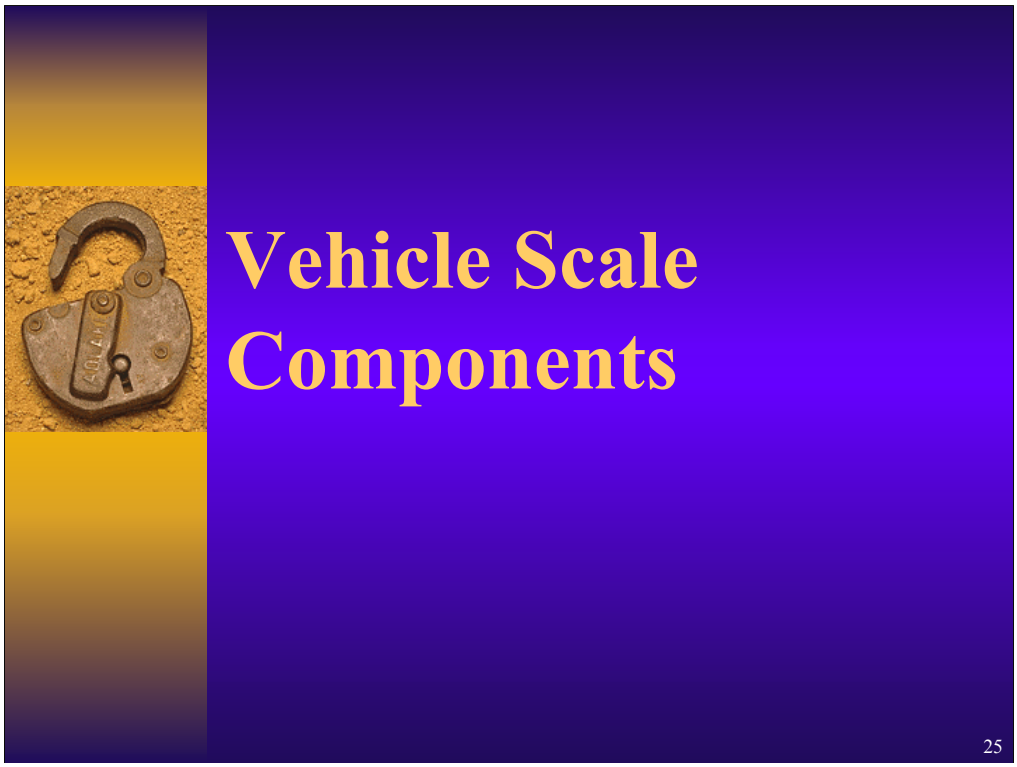
This low profile scale has also been installed under a loading rack and is being used to weigh liquid chemicals.

This truck scale has a mechanical lever type weighing element and was originally equipped with a beam indicator. The beam has been removed and replaced with a digital indicator based upon the location of the scale house in relation to the center of the platform. Also, notice that the scale house is positioned so that the driver's window on trucks can be aligned with one of the windows of the scale house when trucks are fully on the scale platform. By positioning the scale house in this way, drivers can communicate directly with the scale operator and can often observe the actual weighing operation while sitting in their trucks. (See G-UR.2.2. and G-UR.3.3.)

B-Tek Scale

This is a two section, full electronic, low profile, vehicle scale. The entire foundation is concrete facilitating easy clean-out. Many of these smaller vehicle scales are used in agricultural businesses where there is little need for a scale that accommodates larger and heavier combination vehicles. Agricultural commodities such as feed, fertilizer, and grain are routinely weighed on scales similar in size.

This is an electro-mechanical vehicle scale with side levers and load cell fully exposed. Point out exposed levers and connecting load cell. The side levers and the load cell should be housed in a protective cover to prevent wind and weather from adversely affecting the performance of the device. (See UR.2.3.)

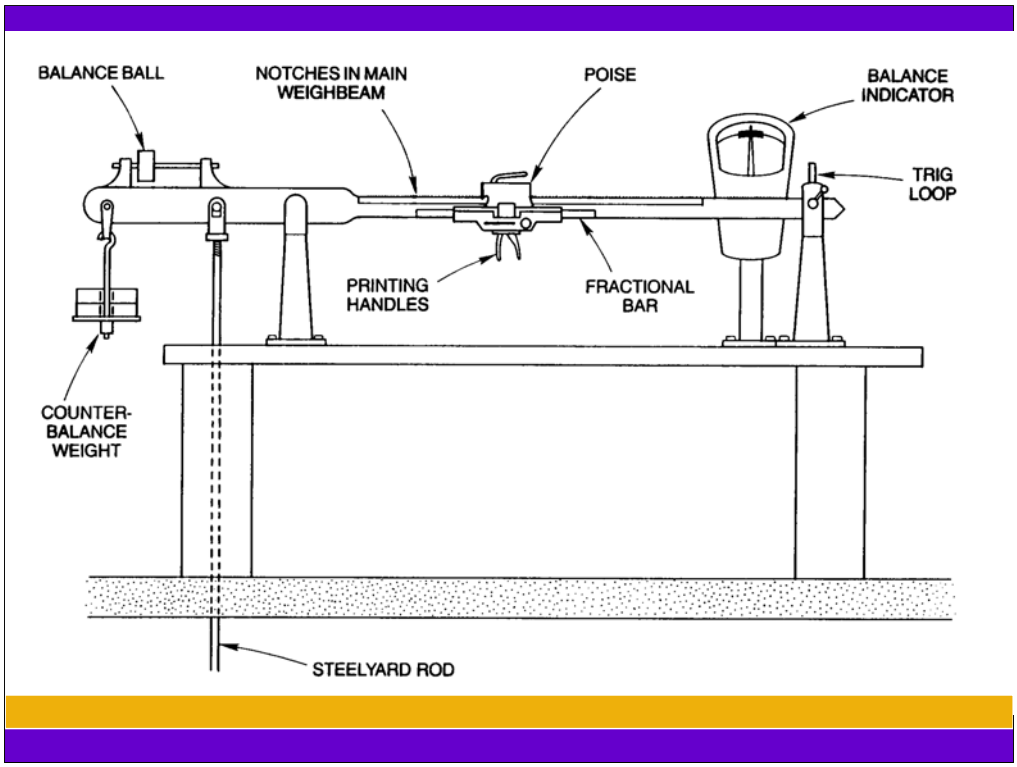


Identifying Scale Components

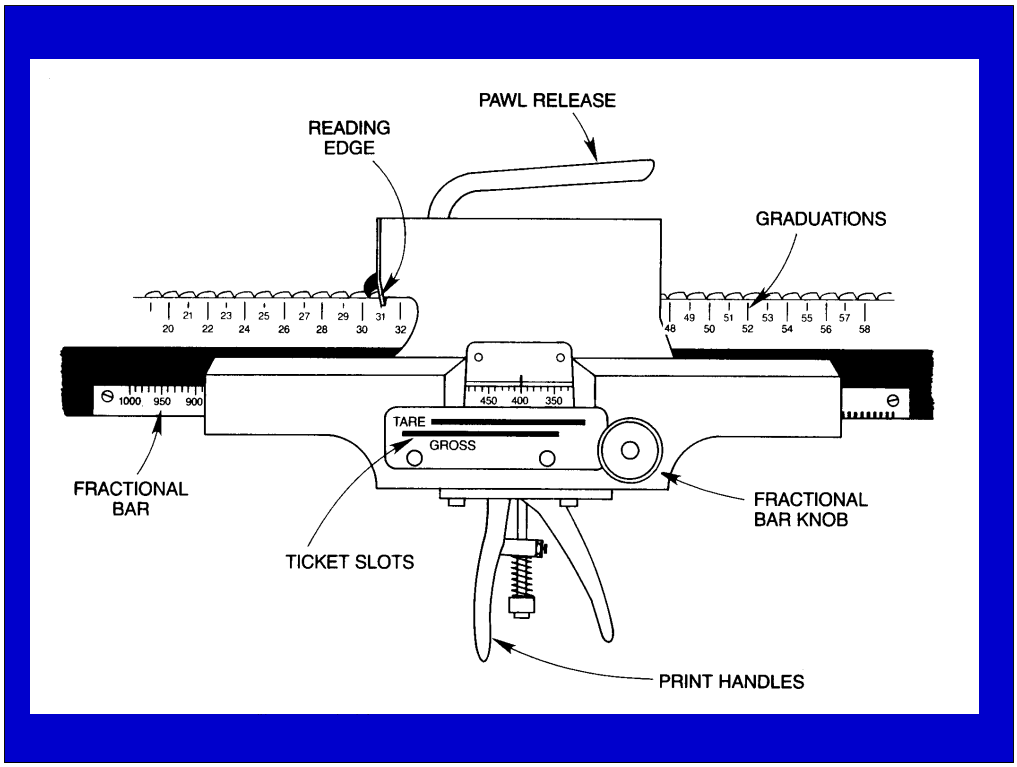
Identify and describe the various scale components shown in this photo. Point out the balance ball, butt hanger, tip hanger, steelyard rod, poise, notched weighbeam, fractional bar, trig loop, print handle, and print mechanism. Also point out the digital display and the printer. Explain the benefits and pitfalls of having two indicators attached to the same load receiving element. (A benefit is that you gain a backup indicator if the digital breaks or there is a power outage. Some pitfalls are that the load cell attachment at the steelyard causes friction and reduces beam sensitivity and both have to be verified and maintained in compliance with HB-44.)

Additional Discussion: Explain how mechanical scales are modified to accept a digital indicator through the installation of a load cell and digital indication.

Identify and describe how the over/under indicator functions.



This is a drawing of a T/R beam indicator. Review the various scale components shown.



Identify and describe the various scale components shown in this diagram. Explain the printing operation of a T/R beam.

This is a Cardinal digital indicator routinely used in truck scale installations. Notice how the display clearly identifies the indicated value as gross and pound. Also notice how the push button operational controls located below the weight display are clearly identified. Such clear and definite identification markings are required by G-S.5.2.4. and G-S.6.

Identify and describe the various scale components shown in this photo. Operational controls are also being identified on this indicator. Notice how symbols are used to identify operational keys. Keys intended for operators use need only be marked to the extent that a trained scale operator understands the function of each key.

This is a remote scoreboard indicator and traffic signal being used to provide customer indications and visual communications. Auxiliary components, such as these, are needed when there is no otherwise direct communication, oral or visual, between an individual located at a primary indicating element or recording element and an individual located at the weighing element. Reference: G-UR.2.2.

This is another auxiliary display allowing customers to observe the weight indication from a reasonable customer position. Because some indicators are installed in restrictive locations, it may be necessary to provide a remote scoreboard when the devices are used in direct sales. Scales used in direct scales must be positioned so that indications may be accurately read and the weighing operation observed from some reasonable customer position. Reference: G-UR.3.3.

This photo shows how a load receiving element is joined together and a canister type load cell installed beneath the section. Leveling legs necessary for leveling the load cell at installation and grouting can be seen along the steel plate that is underneath the load cell. Bolt at left is a check rod adjustment and is used to adjust the limit of side movement in the platform.

This photograph shows the installation of a double ended shear beam type load cell being used in a vehicle scale application. Note clearance between bumper bolt and end wall. These adjustable bumper bolts restrict the amount of longitudinal movement in the platform and the clearance settings vary between platform manufacturers.

This photo shows an S type load cell (machined piece of metal shaped like an S with cable connected in center) and lightening surge protectors (red canister shaped objects connected to either end of load cell). The S type cell is used to install a digital indicator to a mechanical lever system scale – i.e., electro-mechanical types. This cell is installed in the steelyard rod.

Photo shows junction box, load cell cover, and end bumper bolt. Scale sits only on compacted fill. How might the scale's performance be affected if the fill washes out?

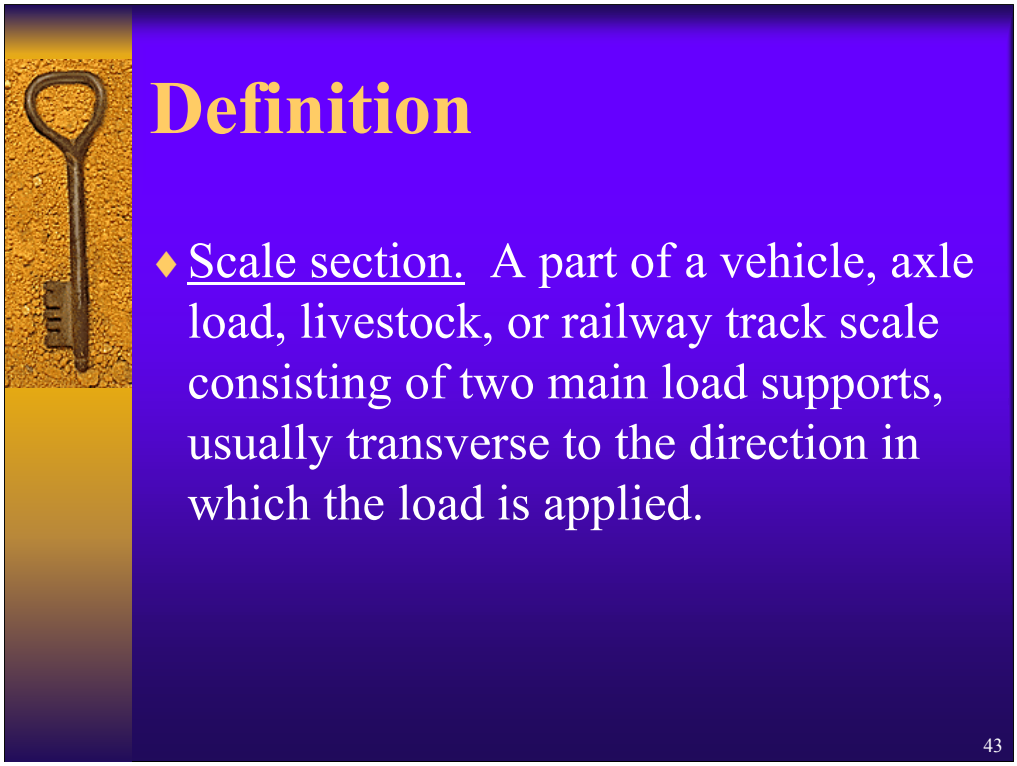
This photo shows a large amount of surface area exposure to the load-receiving element. How would this scale react on a windy day? Also notice the dry, cracked mud which indicates that water builds up around the scale during rain.

This photo shows the load and fulcrum pivot area of a pipe lever scale.

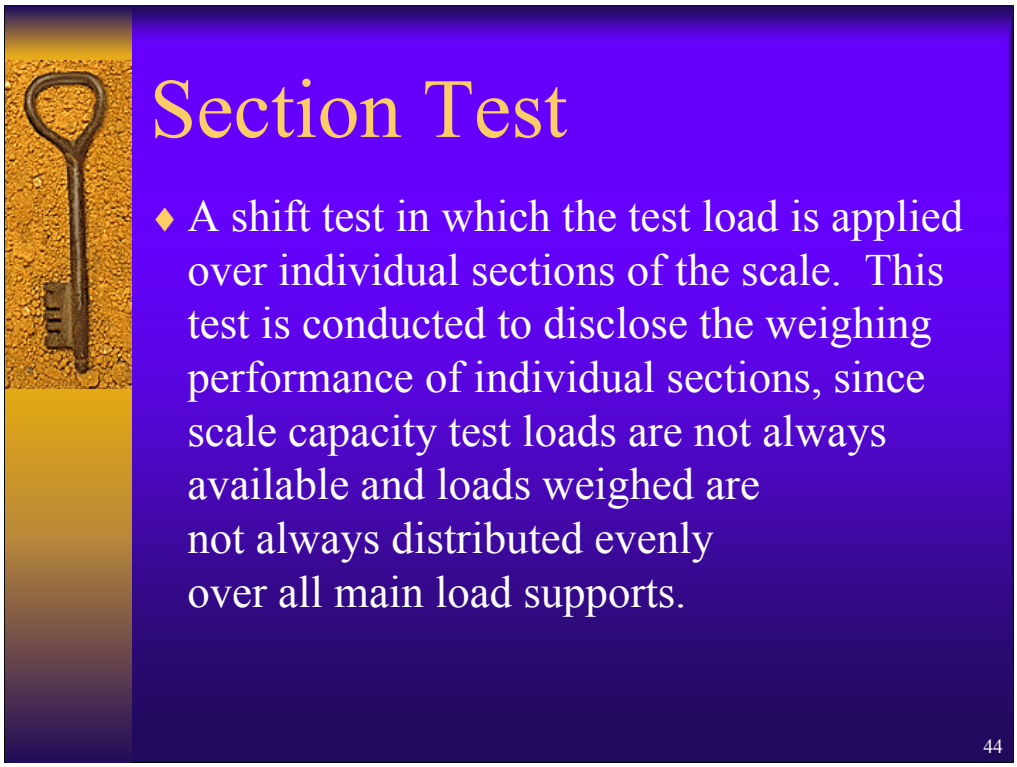
This photo shows the transverse lever and load-receiving element having no protection from environmental elements as required by UR.2.3. The old water tank provides protection to the load cell.

This photo shows two adjacent sections of the load-receiving element butted together over a single pair of load cells. The load cells are not visible, however, they are located on top of the poured concrete pillars directly beneath the metal cover plates on either side of scale. Each load supporting pair of load cells constitutes a section on a full electronic vehicle scale. This photo also shows guide rails securely installed to prevent trucks from traveling off the load-receiving element.

Scale Sections



Read and explain the definition.



Read and explain the definition.

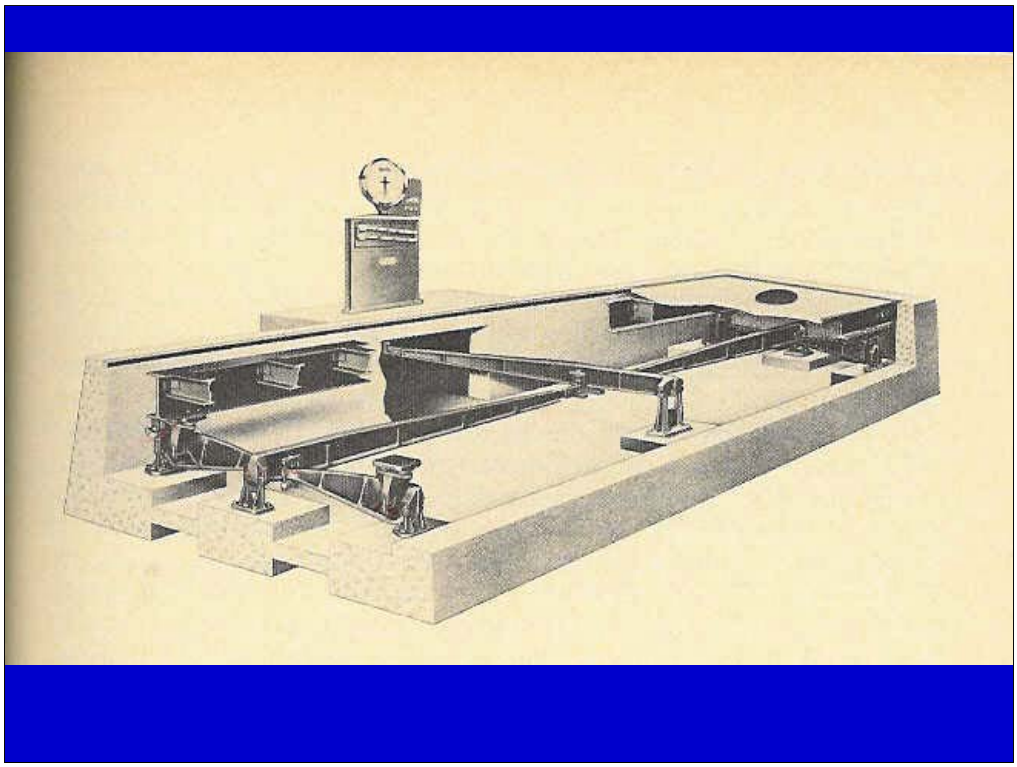
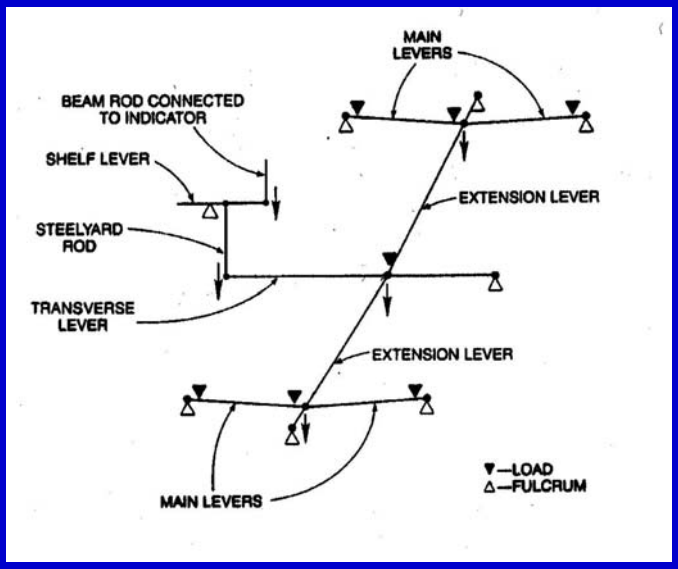


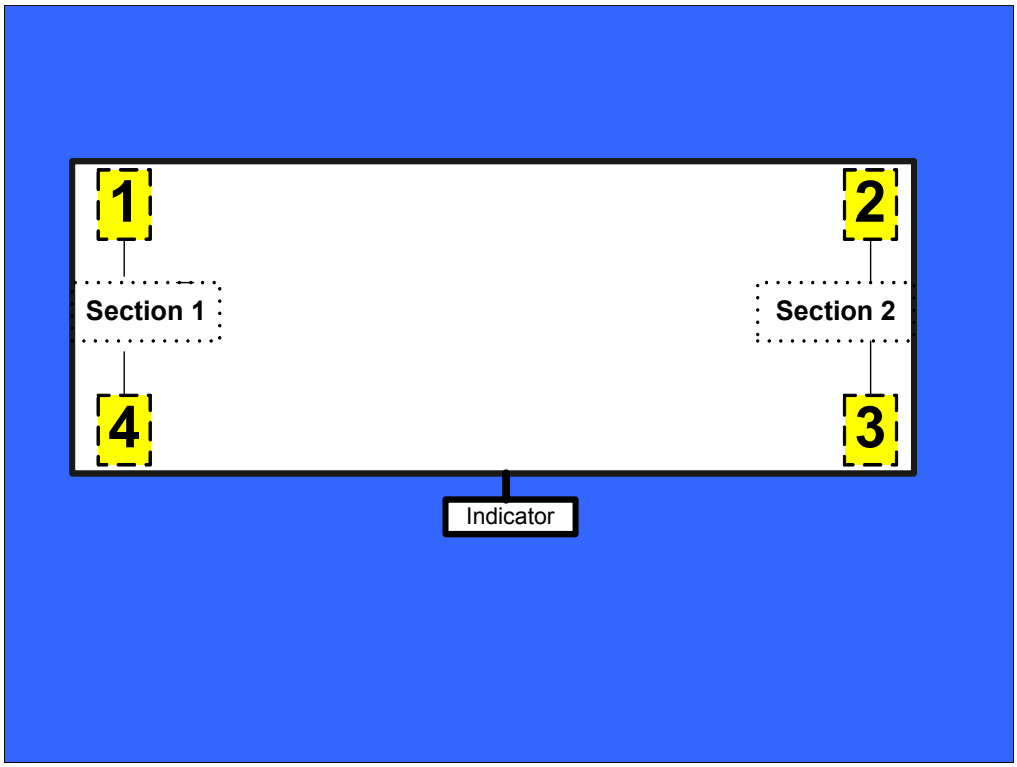
Photo shows the lever system, including both sections of a two section mechanical scale. Identify each section and all of the following in the diagram: main levers, extension levers, transverse lever, and fulcrum stands.

Two Section Scale

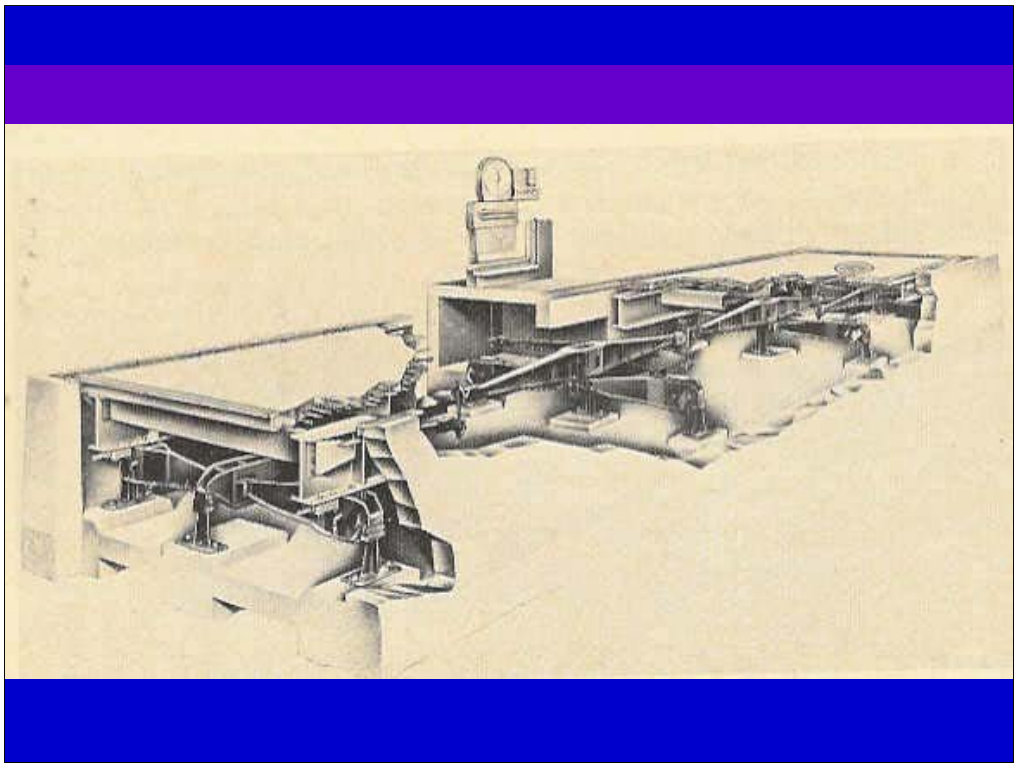


Each section is symmetrically the same.

Diagram shows that each pair of main levers constitutes a scale section. This is a diagram of the two section scale shown in the photo of the last slide. Explain the two purposes of a lever; reduce the force of a load by a precise factor and support the load. Point out the load, fulcrum, and power pivots on each lever in the diagram and demonstrate how each lever reacts when loaded. Explain how the force of load is reduced by the lever system and delivered to the indicating element.



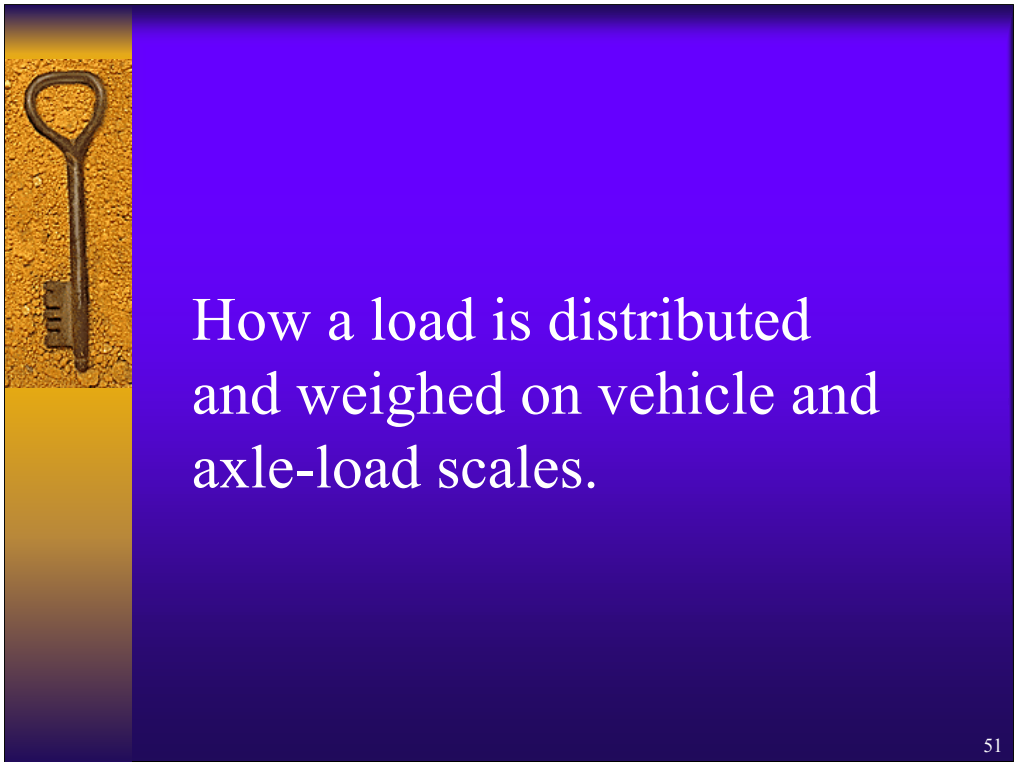
Explain how sections and load points are typically identified.



Identify and describe the scale components being shown in this photo. Photo shows the combination levers found on a four section scale. Describe the dual functionality of the combination lever (serves as an extension lever with a 1:1 ratio to the end sections and serves as a multiplying lever with a 10:1 ratio to the middle two sections).

This is also a scale section! Each load supporting pair of load cells constitutes a section on a full electronic vehicle or axle-load scale.

How do scales typically operate?


How a load is distributed and weighed on vehicle and axle-load scales.
51

End View of Lever System

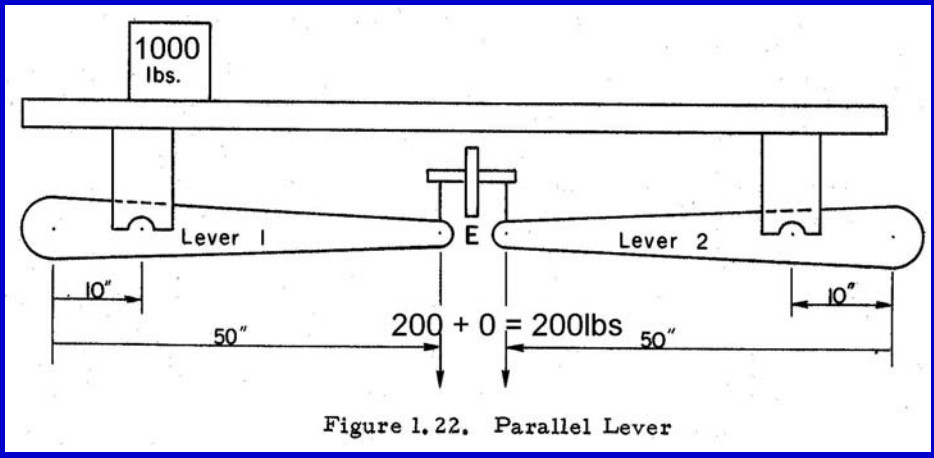
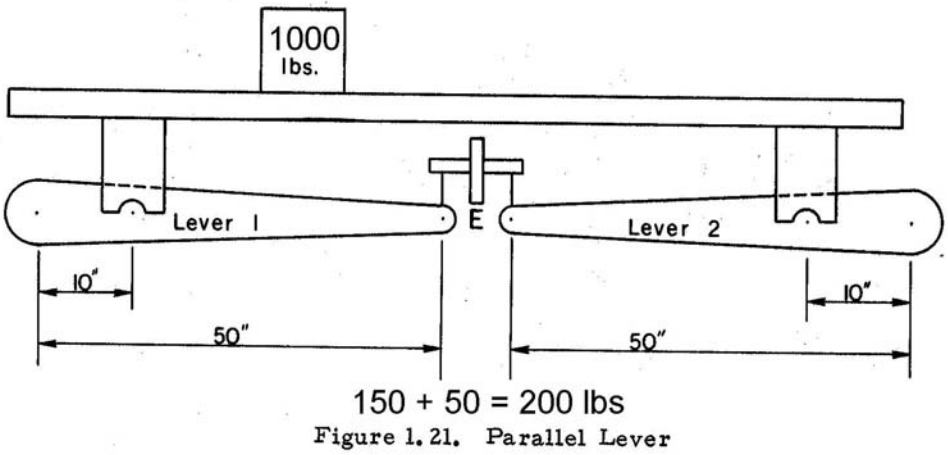


Figure 1.22. Parallel Lever

Scaleman's Handbook of Metrology

Diagram shows end view of truck scale where levers 1 and 2 are the main levers and lever E is an extension lever. The multiple of levers 1 and 2 is 5:1. The diagram shows lever 1 receiving and reducing the entire load. Lever 2 is not participating. Describe a lever train and how the multiple of the scale is determined by multiplying the ratios of the levers in the train together.



150 + 50 = 200 lbs

Figure 1.21. Parallel Lever

Scaleman's Handbook of Metrology

Diagram shows that as the load is moved across the width of the platform, both main levers participate in the reduction of the force of the load by proportional amounts depending on the location of the load.

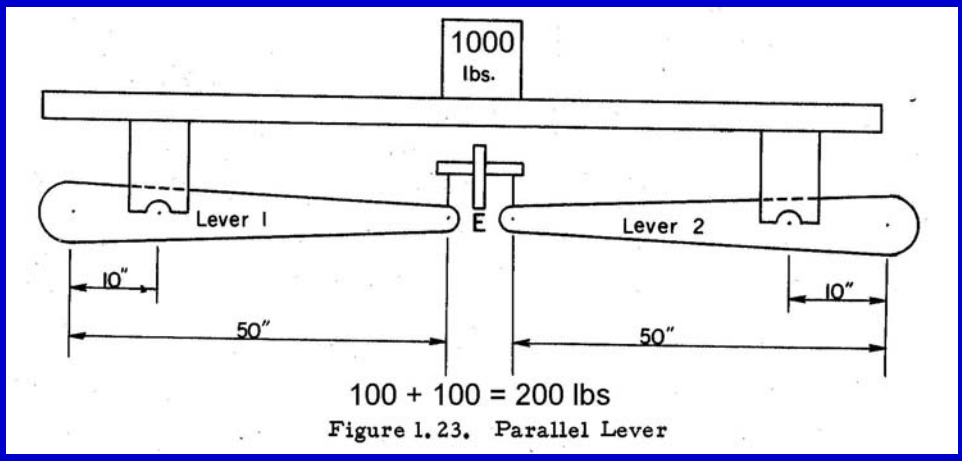
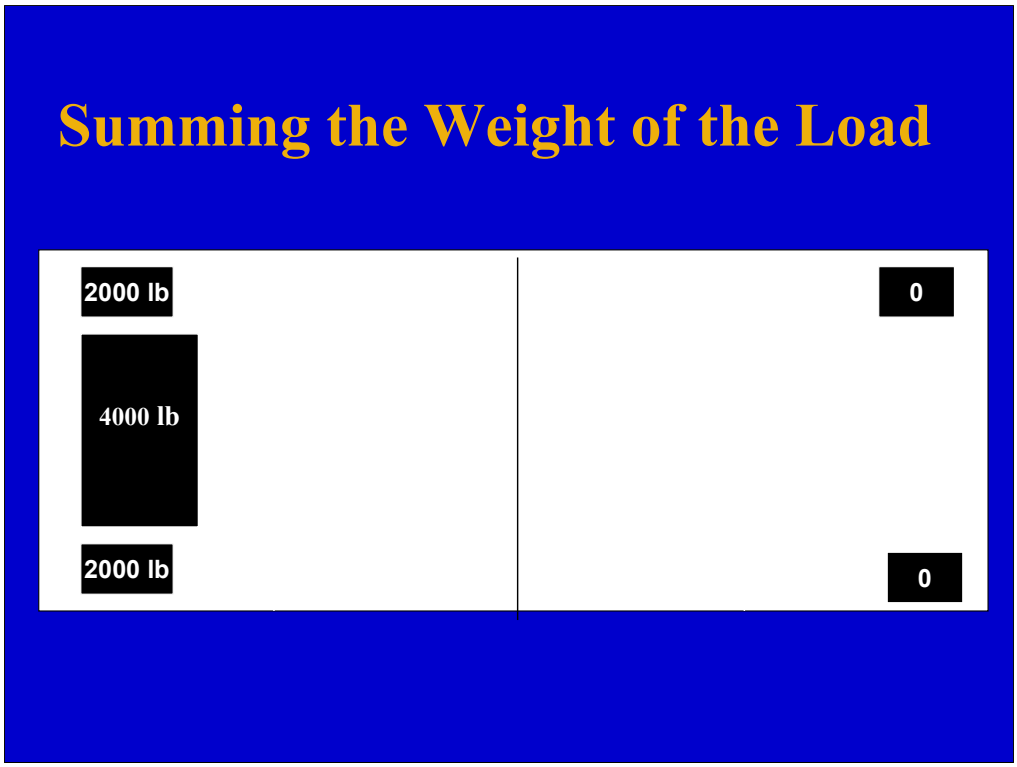


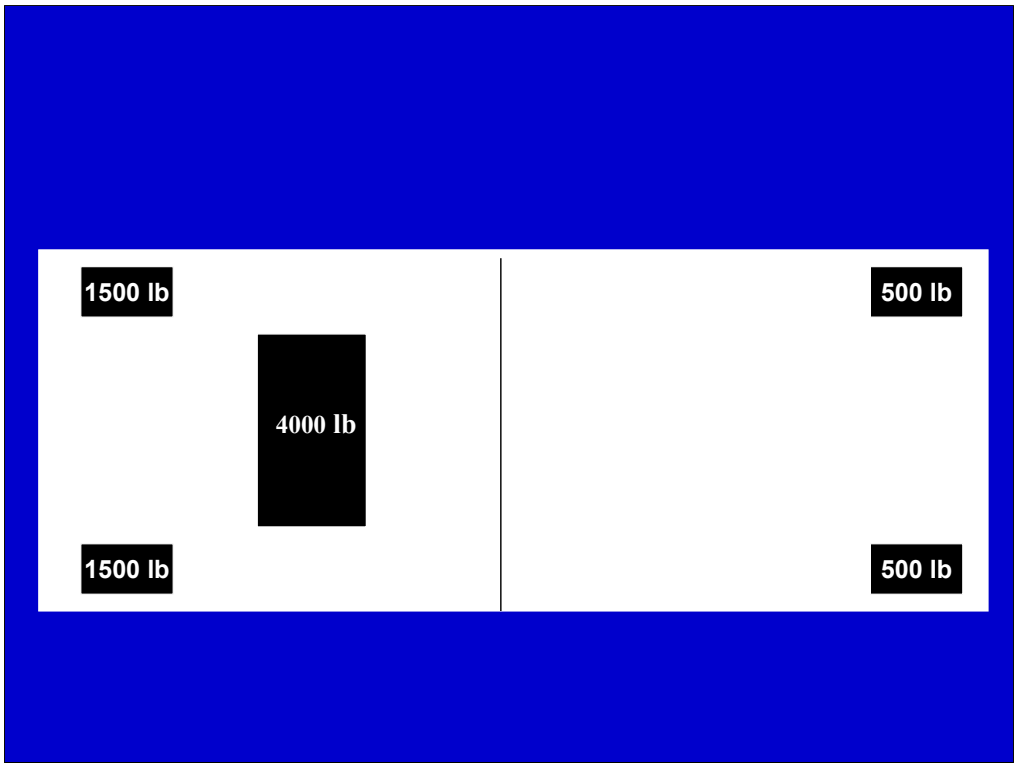
Figure 1.23. Parallel Lever

Scaleman's Handbook of Metrology

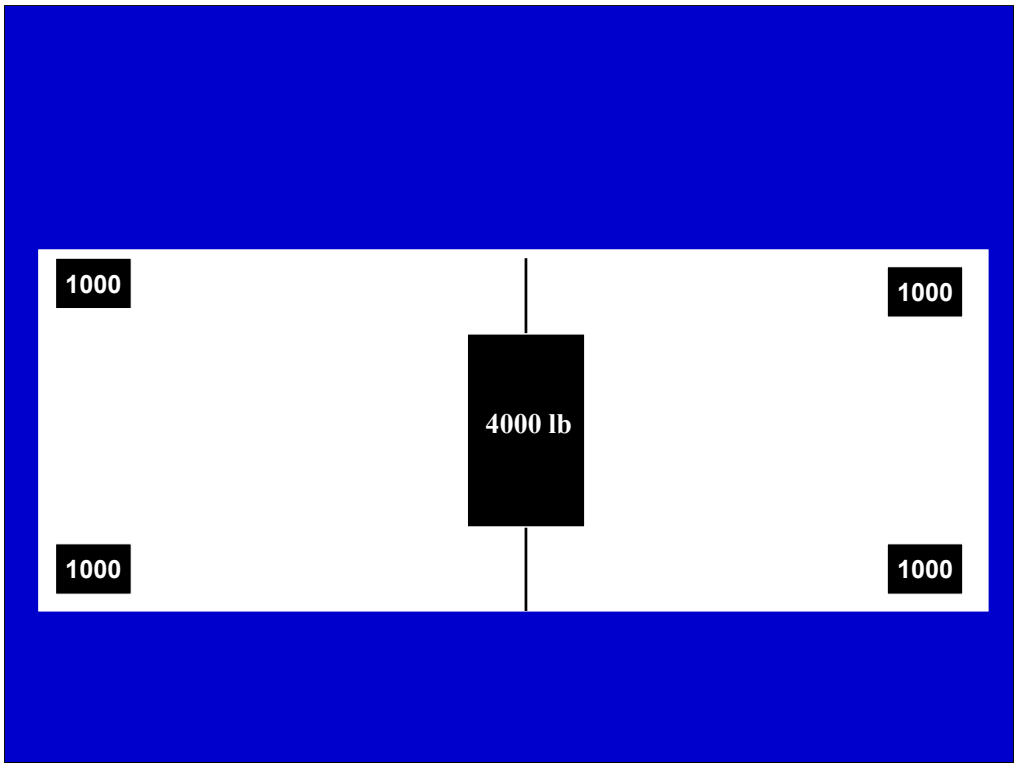
Diagram shows that when the load is placed directly in the middle of the width of the platform, both main levers participate equally in the reduction of the force of the load. This diagram, and the previous two, show how the lever system functions to reduce the force of a load when the placement of the load is moved over the **width** of the platform.



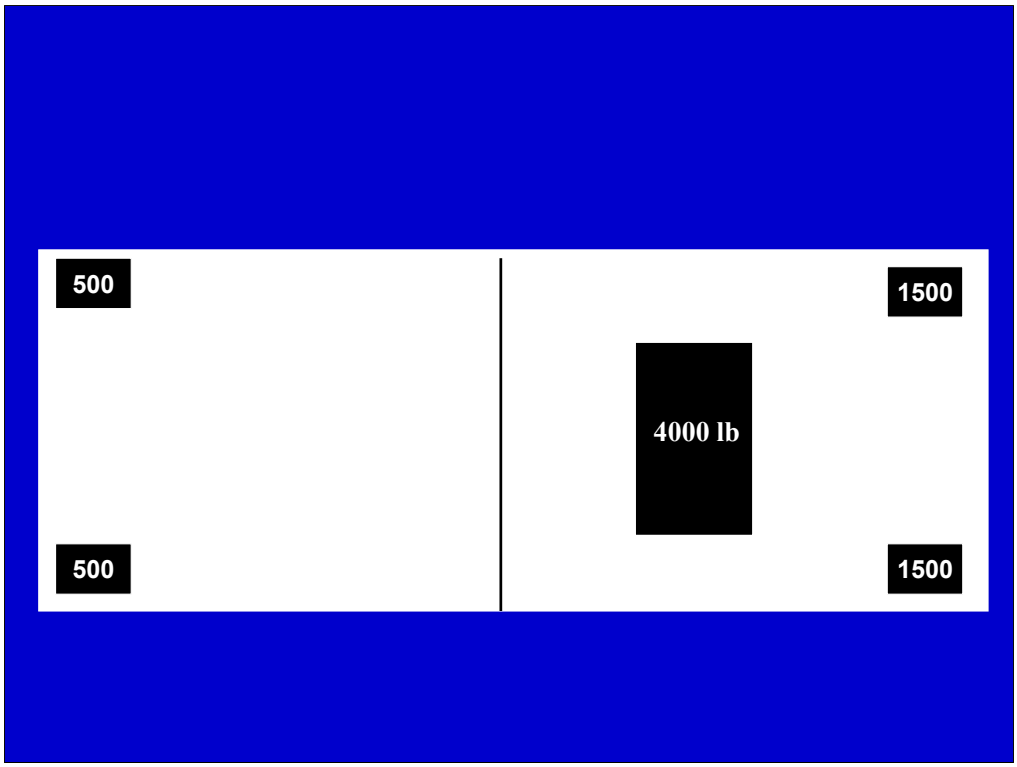
This drawing shows how a load is divided and weighed through the lever system of a vehicle scale when the load is placed directly over an end section and equidistant between the main load supports.



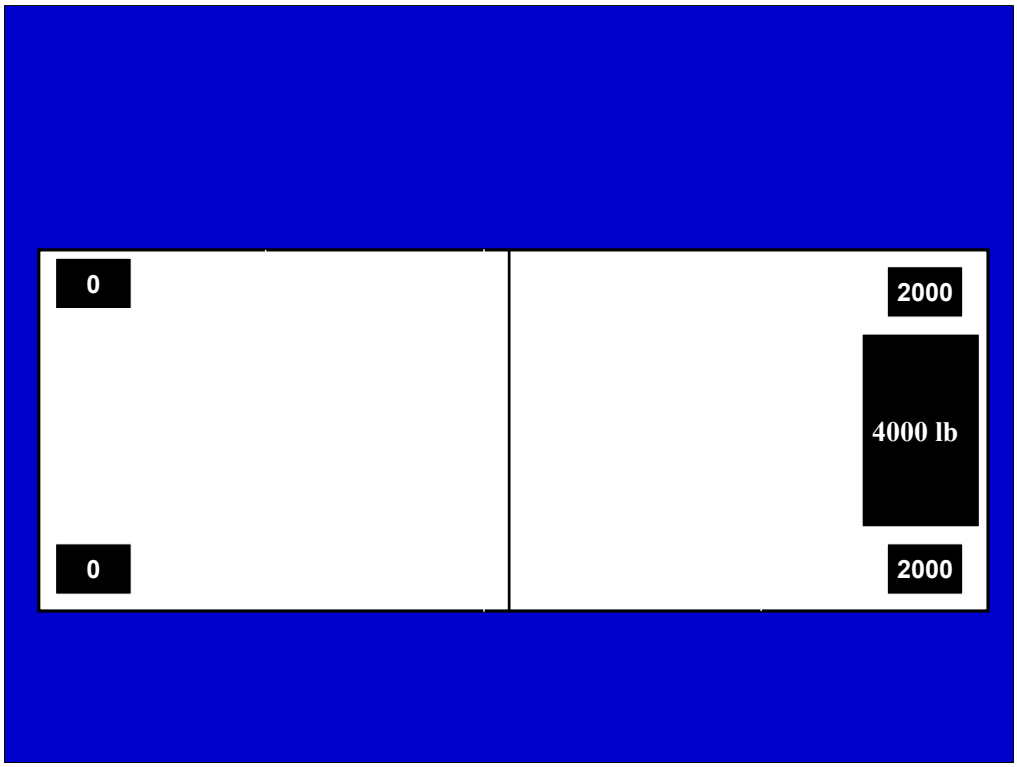
This drawing shows how a load is divided and weighed through the lever system of a vehicle scale when the load is moved over the length of the platform. Notice the change in value of the corners.



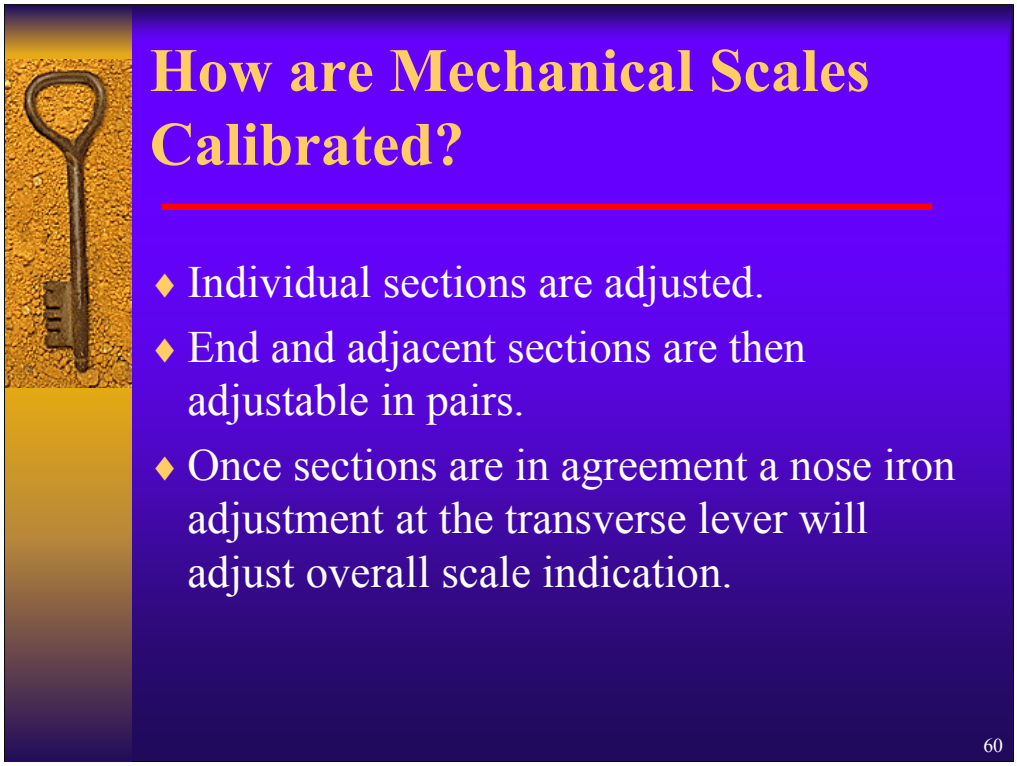
This drawing shows how a load is divided and weighed through the lever system of a vehicle scale when the load is moved over the length of the platform. Notice that each corner weighs the same when the load is placed directly in the middle of the platform.



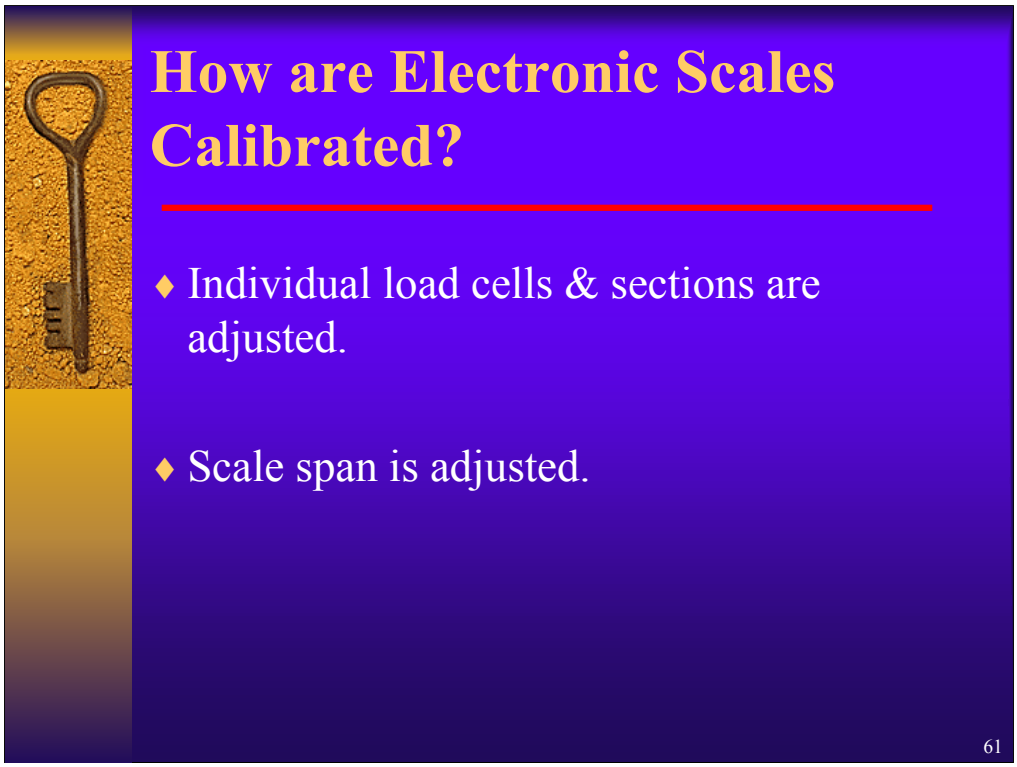
This drawing continues to show how a load is divided and weighed through the lever system of a vehicle scale when the load is moved over the length of the platform. Notice the continuing change in value of the corners.



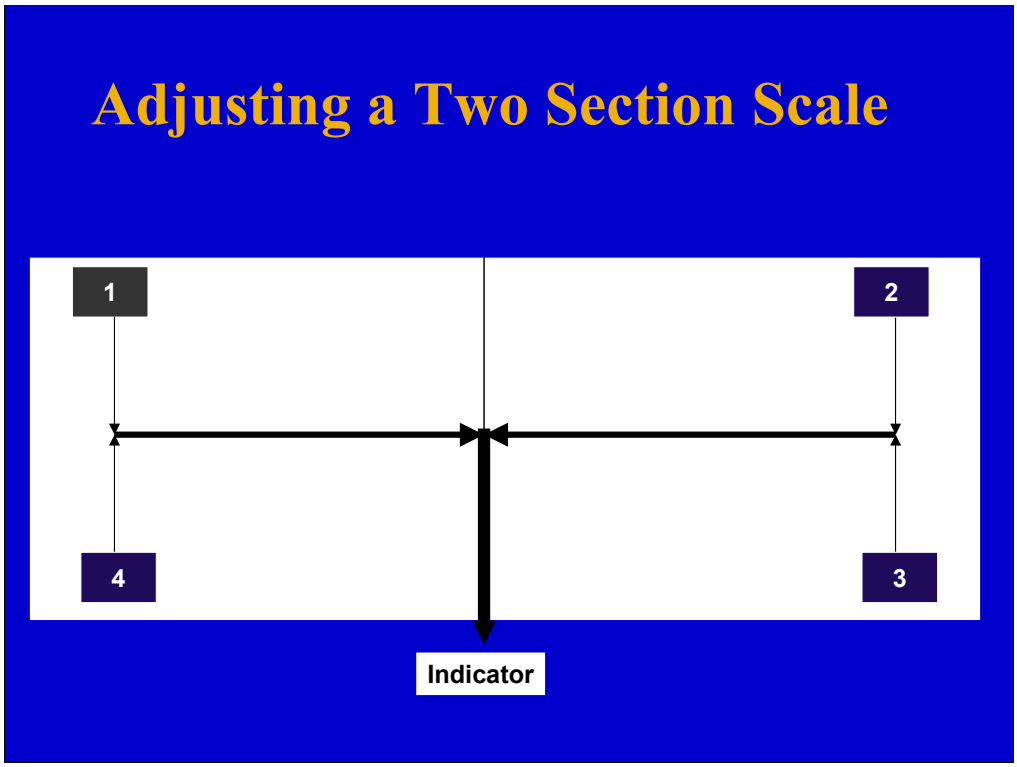
This drawing continues to show how a load is divided and weighed through the lever system of a vehicle scale when the load is moved over the length of the platform. The load has now completed its path from one end to the other. Notice the change in corner values.



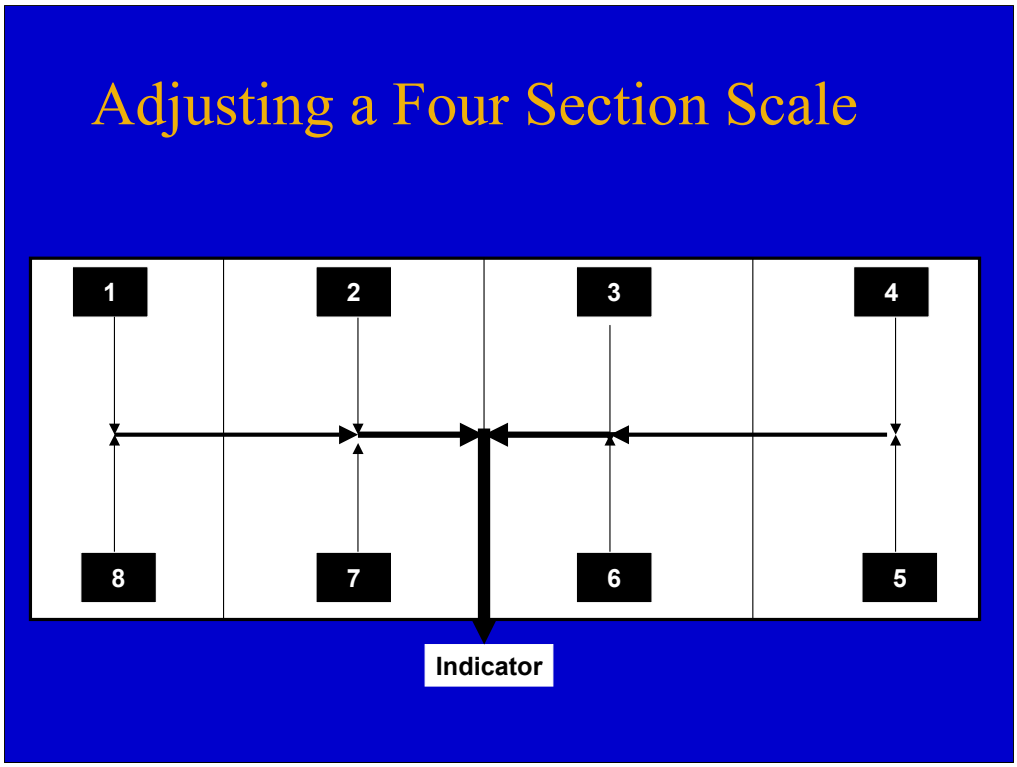
Explain how a two section mechanical truck or axle-load scale is calibrated.
Explain how a four section mechanical truck scale is calibrated.



Explain how a typical electronic truck scale with analog load cells is calibrated. Explain how an electronic truck scale having digital load cells is calibrated differently than the analog cell type.

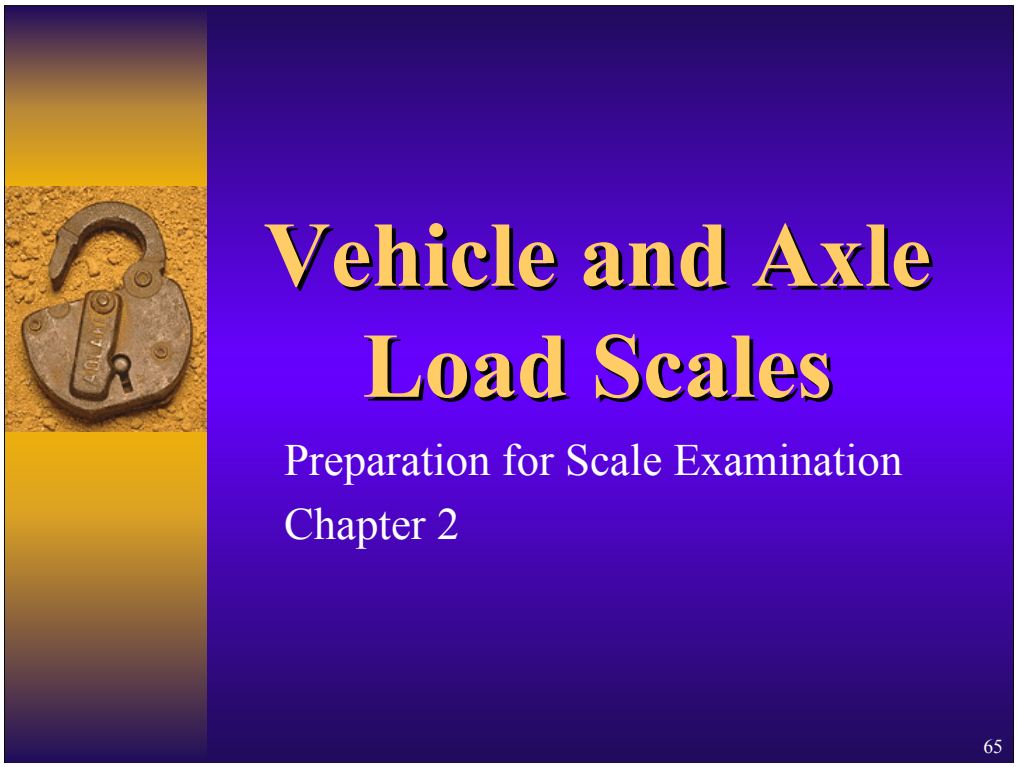


Explain how a two section scale is calibrated using this slide to demonstrate.



Explain how a 4 section scale is calibrated using this slide to demonstrate.

Summary of subjects covered in Chapter 1.



Purpose of Chapter 2.

-Describe the purpose of device inspection by weights and measures jurisdictions.

-Identify references for legal and technical requirements of device inspection.

-Identify equipment needed for scale examinations and identify some potential safety hazards associated with heavy capacity scale inspections.

-Explain the meaning of the following terms:

accurate

approval seal

commercial weighing and measuring device

correct

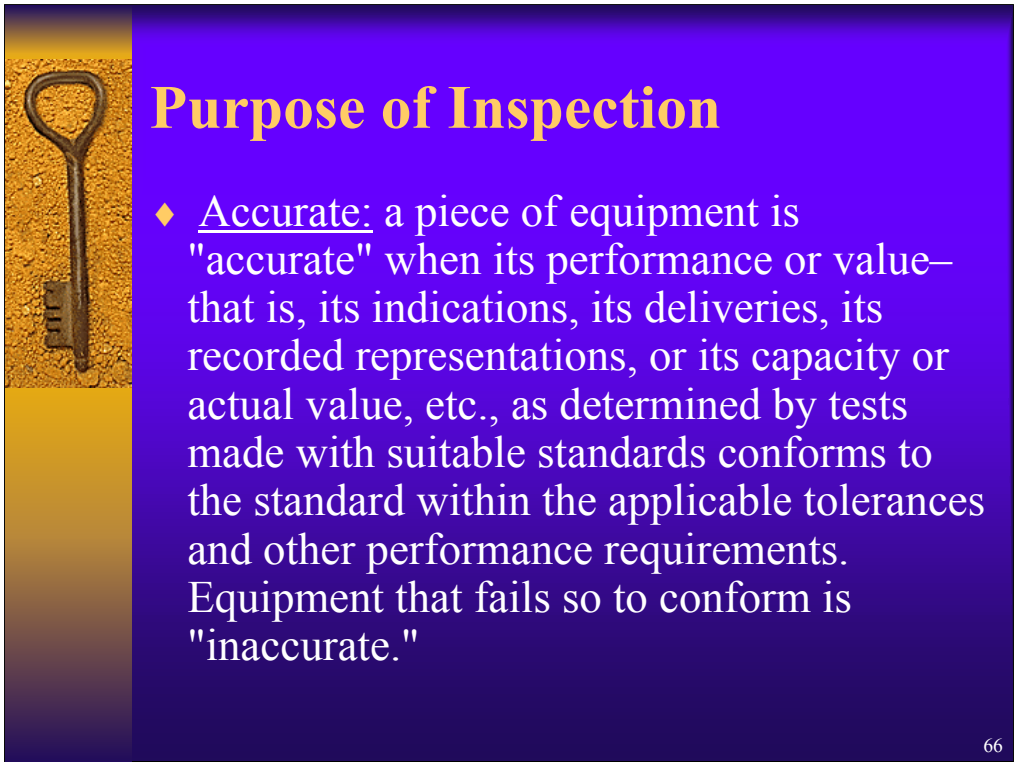
primary standards

secondary standards

security seal

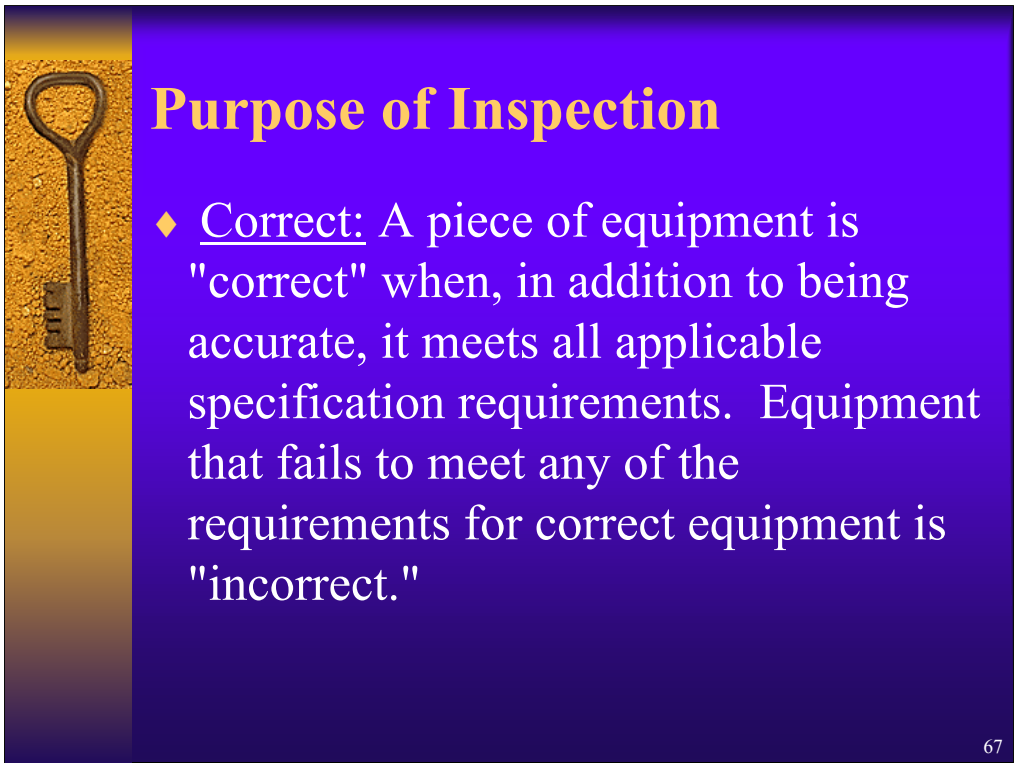
specification

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.



Basic: Read definition and explain how the term relates only to the performance portion of the official examination. Explain how it is possible for a device to be accurate but not correct.

Reference: Fundamental Considerations 4.7.



Read definition and explain how this term is used to identify a device's conformance to all specification and accuracy requirements.

Reference: Fundamental Considerations 4.7.

Emphasize the need to exercise proper safety procedures and to take adequate safety precautions when working around heavy capacity scales and associated inspection equipment. Discuss real life incidents for which you are familiar to make your point.

-Cranes

-Power lines

-Weights

- 1000 lb cannonballs

Discuss some potential hazards associated with crane operation. Always follow the crane manufacturer's recommended safety procedures when operating the equipment. Please stress that when thousand pound weights are dropped from cranes or fall from carts they can be as devastating as a cannon ball.

- **Environments**
- **Alarms in chemical and other plants.**
- **Safety equipment**
- **Traffic**
- **Climbing on and off of trucks.**

Discuss the potential hazards and provide some recommended safety precautions relating to bulleted items.

Unloading and moving carts.

Working with partners.

Breaking through scale decks.

Discuss the potential hazards and provide some recommended safety precautions relating to the items listed.

Traction, Braking, Flipping

Discuss the potential hazards and provide some recommended safety precautions relating to the operation of weight moving equipment, including weight carts. Weight carts with smooth hard tires lose traction easily. Weights stacked inside of carts tend to slide easily, especially when condensation has formed. Such sliding can cause cart to flip, resulting in severe injury to operator. Always balance weights evenly inside of carts, completely filling floor area of cart before adding any additional tiers. Exercise caution when moving test carts with two or more tiers of weight stacked inside the cart.

Pit Inspections

Confined Spaces

Fumes and other Hazards

Especially dangerous when under repair.

Discuss the potential hazards and provide some recommended safety precautions relating to scale pits.

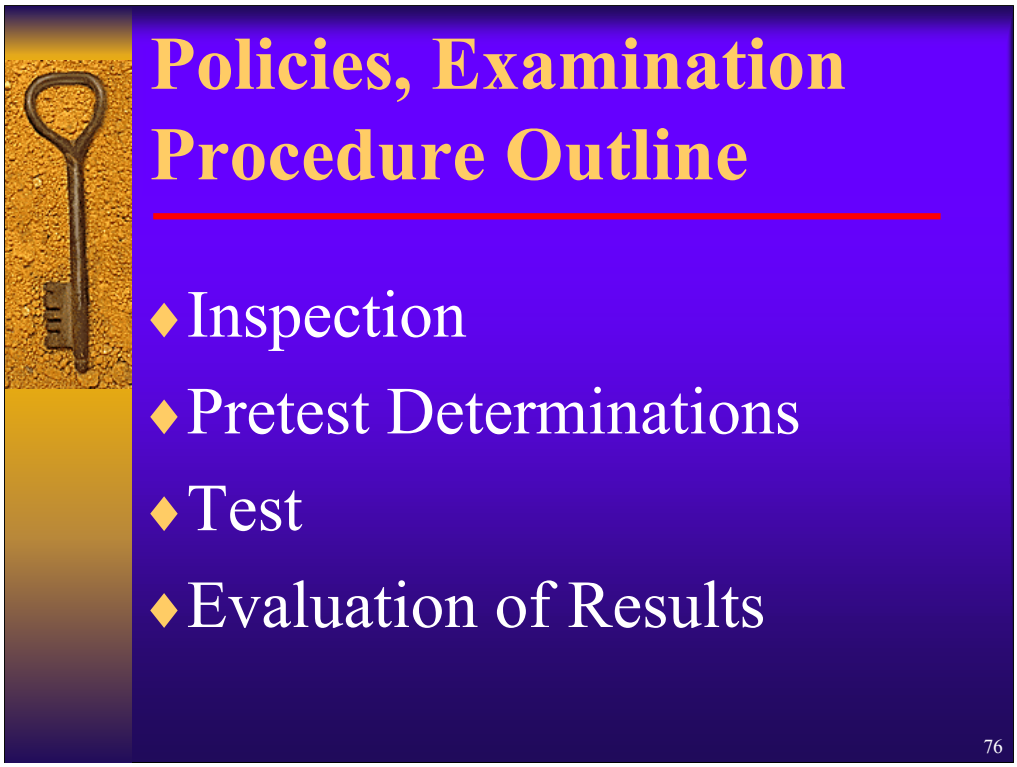
Inspections

Fall and trip hazards.

Driving off scale.

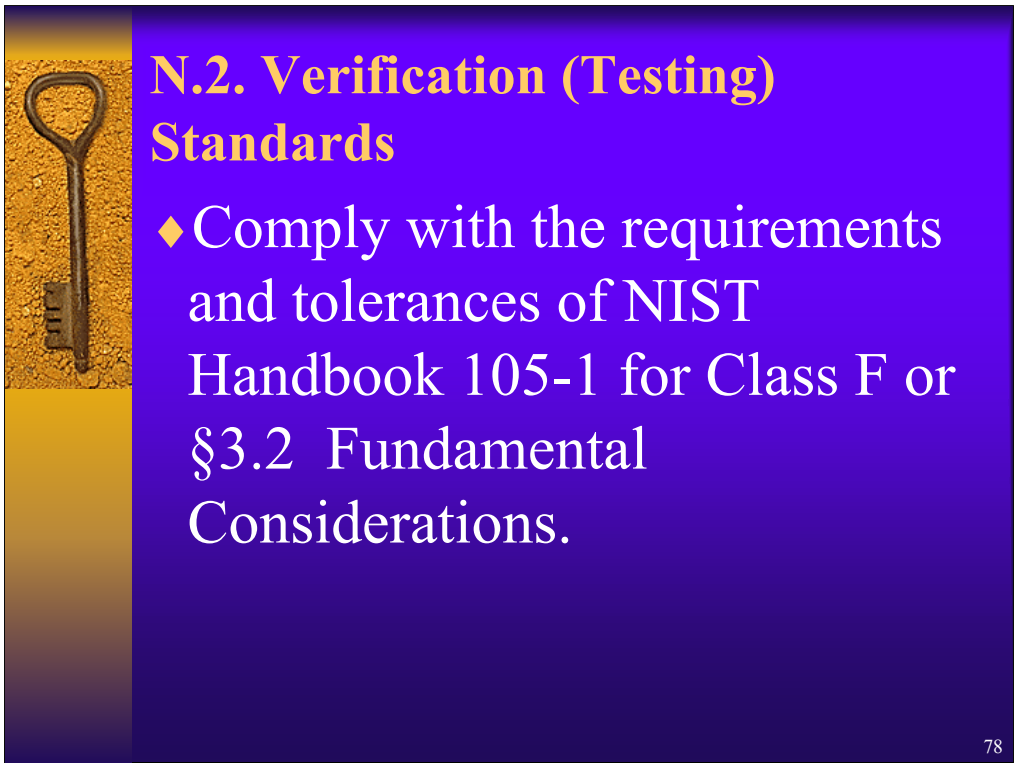
Discuss the potential hazards and provide some recommended safety precautions relating to bulleted items.

Test cart with two tiers of weights properly stacked inside. Notice how weights are balanced between the wheelbase of the cart.



Describe the need to have the correct EPO and pertinent program policies available when performing a scale examination. Bulleted items are sections found in the EPO. Describe how policies created by the administration of a weights and measures jurisdiction can assist field officials in the performance of their duties.

Items listed are also needed when conducting a field examination of a vehicle or axle-load scale.



Read/Summarize N.2. and also Fundamental Considerations 3.2. Emphasize the need for officials to know the accuracy of the field standards they are using and that each standard be maintained within the accuracy requirements of Handbook 105-1 for Class F standards. Explain the importance of maintaining a like new appearance of test standards and all associated test equipment. Explain how errors in individual standards that are used in combination to test a scale can be added together so that the total amount of error in all the standards combined exceeds the tolerance applicable to a single standard of the same weight.

Explain how these standards might be used to test large capacity scales as part of an error weight test load.

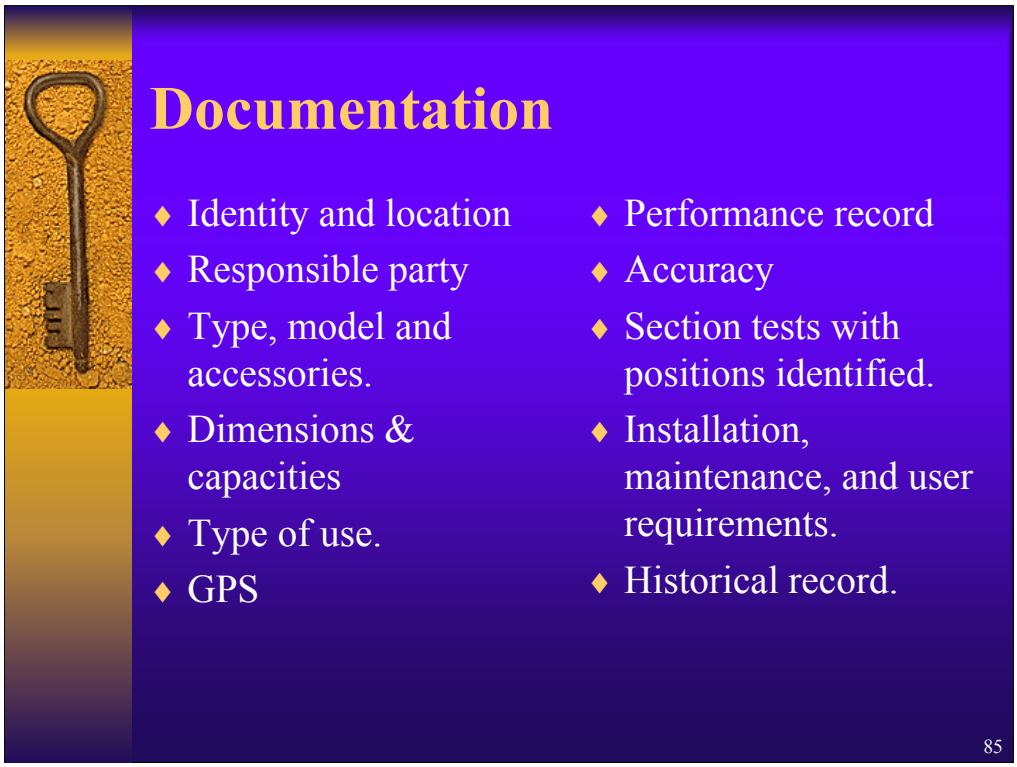
The next five slides show different types of vehicle and axle-load scale testing equipment in use by several states in the U.S. This is a six wheel gasoline powered test cart that can be loaded up to 40,000 lb.

The second of five slides showing different types of vehicle and axle-load scale testing equipment in use by several states in the U.S.

The third of five slides showing different types of vehicle and axle-load scale testing equipment in use by several states in the U.S. This gas powered tractor, called a "goat," can pick up and move 3-1000lb weights at a time.

The fourth of five slides showing different types of vehicle and axle-load scale testing equipment in use by several states in the U.S.

The fifth of five slides showing different types of vehicle and axle-load scale testing equipment in use by several states in the U.S. This articulated crane can easily lift and swing 5,000 lbs at one time with the intermediate boom and stinger in a fully extended position.



Bulleted items, if applicable, need to be documented on a report form and a copy of the report maintained for future inspection use. Reports should be neatly written providing accurate and concise documentation of examination results. Discuss how past records of device inspections can benefit field officials in the performance of their duties.

Summary slide of material covered in Chapter 2.