Verification, Certification and In-service Inspection of Non-automatic Weighing Instruments

Training Resources

The training resources required to complete this module include:

- Learners Manual;
- Non-automatic weighing instruments;
- Reference standards;
- NMI V 0 Uniform Test Procedures: General Information; and
- NMI V 1 Uniform Test Procedures for Non-automatic Weighing Instruments.

4

This training module has been developed by the National Measurement Institute for use in the Diploma of Engineering Trade Measurement.

During this training module there are a number of incidences where photographs of non-automatic weighing instruments are used to demonstrate particular problems. In these cases the problems have been simulated for training purposes only.

5

Australia's National Measurement System

8

Australia's National Measurement System

Measurements of one type or another affect all individuals and organisations in many ways every day and allow us to make quantitative decisions in areas such as:

- Commerce;
- Industry;
- Science;
- Engineering;
- International Trade;
- Health and Safety; and
- The Environment.

9

Australia's National Measurement System

Australia is fortunate to have a national measurement system which has the infrastructure to ensure consistent and internationally recognised measurements.

This system is made up of four national organisations which are complemented by trade measurement and verifying authorities.

10

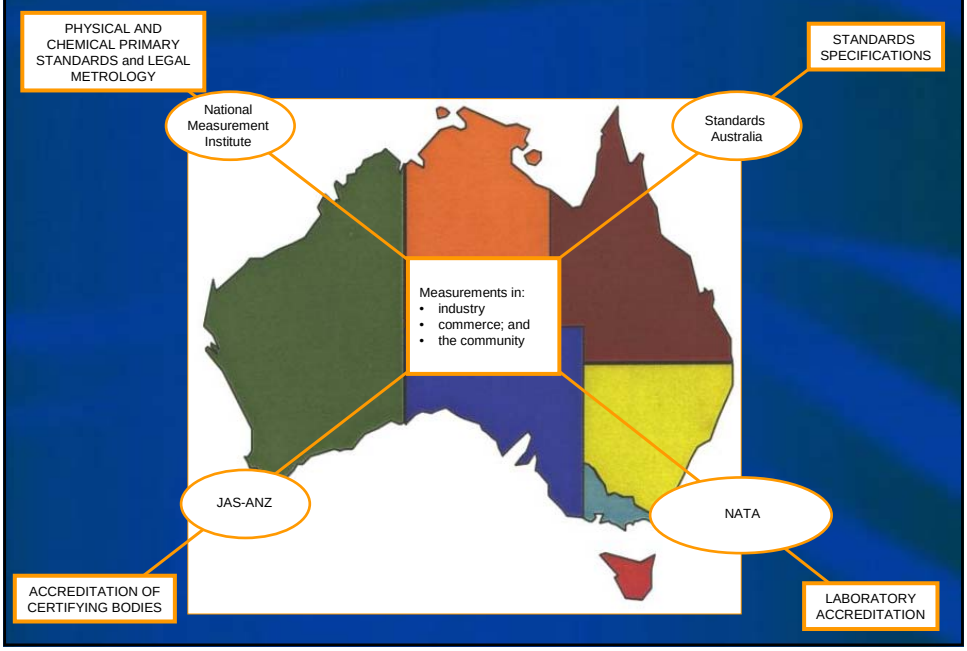
Australia's National Measurement System

These national organisations include:

- The National Measurement Institute (NMI);
- the National Association of Testing Authorities (NATA);
- Standards Australia International (SAI);
- Joint Accreditation System of Australia and New Zealand (JAS-ANZ).

11

What are the main areas of responsibility for these organisations



National Measurement Institute

The National Measurement Institute (NMI) was established on 1 July 2004, by amalgamating the National Measurement Laboratory (NML), the National Standards Commission (NSC) and the Australian Government Analytical Laboratories (AGAL).

NMI administers the *National Measurement Act 1960*. It has specific responsibilities for:

- Development and maintenance of national standards of measurement;
- Provision of measurement services to industry, scientific organizations and government;
- Transfer of measurement technology and expertise to industry;
- Promoting uniformity in national trade measurement policy and practice.
- Fulfilling Australia's International obligations with respect to measurement.

13

Legal Metrology

Legal metrology encompasses all measurements carried out for legal purpose. It includes all measurement that is subject to regulation by law or government such as measurement for traffic control, occupational health and safety and environmental monitoring. This also includes trade measurement.

14

Trade Measurement

The Institutes' responsibilities for trade measurement include:

- the pattern approval of measuring instruments;
- the pattern compliance of production instruments with a certificate of approval; and
- coordination of the trade measurement system.

15

Pattern Approval

Pattern approval is the process whereby an impartial body examines the pattern (design) of an instrument prototype against a set of national or international metrological specifications.

In the case of non-automatic weighing instruments the National Measurement Institute (NMI) examines an instrument prototype against a set of national metrological specifications described in NMI R 76.

Document NMI R 76 is based on the international specifications described in OIML R 76.

16

Pattern Approval

The pattern approval process determines whether an instrument is capable of retaining its calibration over a range of environmental and operating conditions while it is not capable of facilitating fraud.

Pattern approval protects measuring instrument manufacturers and importers from substandard measuring instruments that would otherwise provide unfair competition.

Pattern approval provides confidence that all measuring instrument will meet certain metrological standards of performance over a range of operating conditions and will not need to be excessively recalibrated. As a result the parties to the measurement are also protected.

17

Pattern Compliance

A statistically significant number of production instruments are randomly checked to ensure that they comply with the certificate of approval. This aims to protect consumers and ensure the instruments comply with the certificate of approval.

If the production instrument does not comply with the certificate of approval, they may not be able to maintain calibration leading to inaccurate measurements, disputes and significant transaction costs.

Mutual recognition agreements are being developed between countries with similar pattern approval capabilities to reduce the number of times an instrument manufacturer has to get the same instrument approved.

A metrological control system sufficient to satisfy Australia's international obligations and Australian law requires all production measuring instruments to be verified or certified in order to be approved for trade use. It is the responsibility of the owner/user to ensure their instrument is delivering correct measure.

Verification or certification is the process whereby instruments are:

- inspected to ensure they comply with the certificate of approval;
- tested to ensure they are operating within the maximum permissible errors; and
- Verified/certified by marking the instrument with a mark.

Verification:
Is performed by an inspector in order to mark the instrument indicating that it conforms to the requirements outlined in the Uniform Test Procedures.

Certification:
Is performed by a certifier in order to mark the instrument indicating that it conforms to the requirements outlined in the Uniform Test Procedures.

In-service inspection:
Is performed by an inspector or certifier to test the accuracy of measuring instruments that have been in use for some time.

20

Metrological Control of Measuring Instruments

An efficient metrological control system provides control of measuring instruments used for legal purposes such as environmental monitoring, traffic control, health and safety, and trade.

This requires a uniform approach to the pattern approval, verification, certification and in-service inspection of measuring instruments.

Australia's measurement infrastructure ensures traceability of the standards used to verify or certify measuring instruments.

21

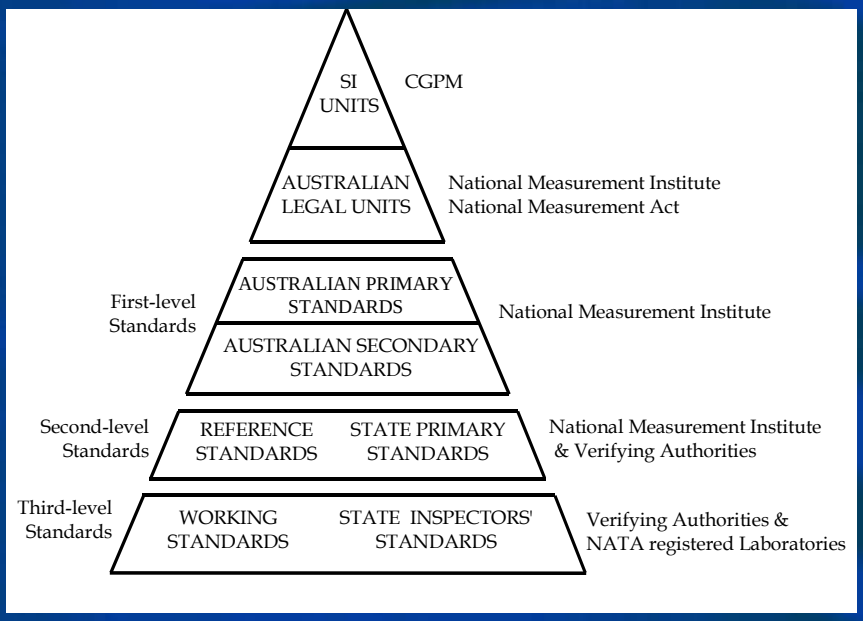
Traceability

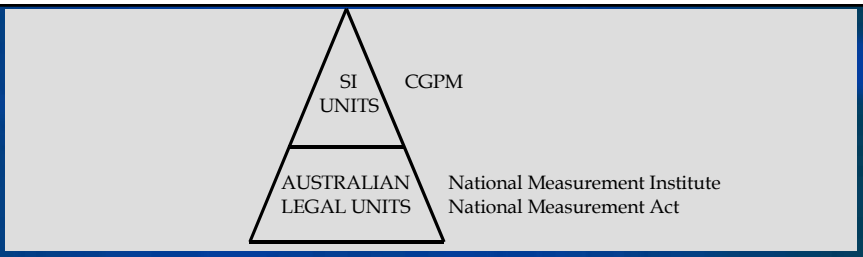
Traceability is when a physical measurement is related back through the national metrological pyramid to the relevant base unit.

This is commonly referred to as the hierarchy of standards.

22

Australia's Metrological Pyramid

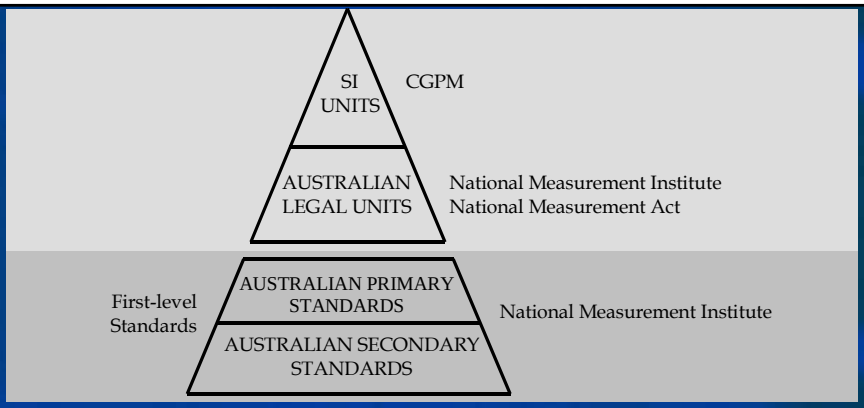




The International System of units (SI units) which was adopted by international agreement at the General Conference of Weights and Measures (CGPM) in 1960 is at the top of the pyramid. The SI units form the basis of Australia's hierarchy of standards.

The National Measurement Act prescribes the Australian Legal Units for all physical quantities of measurement in Australia. These units include SI base units of measurement, derived and supplementary units and combinations of these units, with the exception of a few specific quantities which may still be measured in non-SI units.

24



The National Measurement Act requires the National Measurement Institute (or its agents) to maintain standards of measurement necessary to provide means for measurements of physical quantities in terms of the legal units.

Australian primary and secondary standards are maintained by the National Measurement Institute (and its agents).

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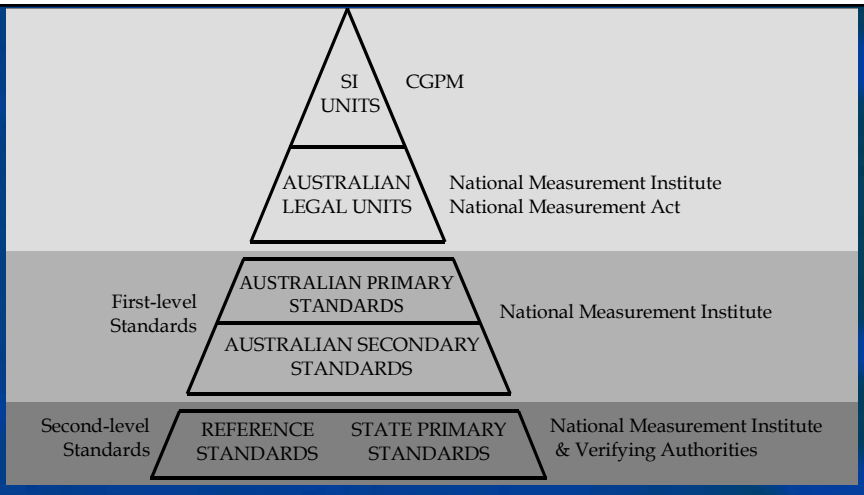
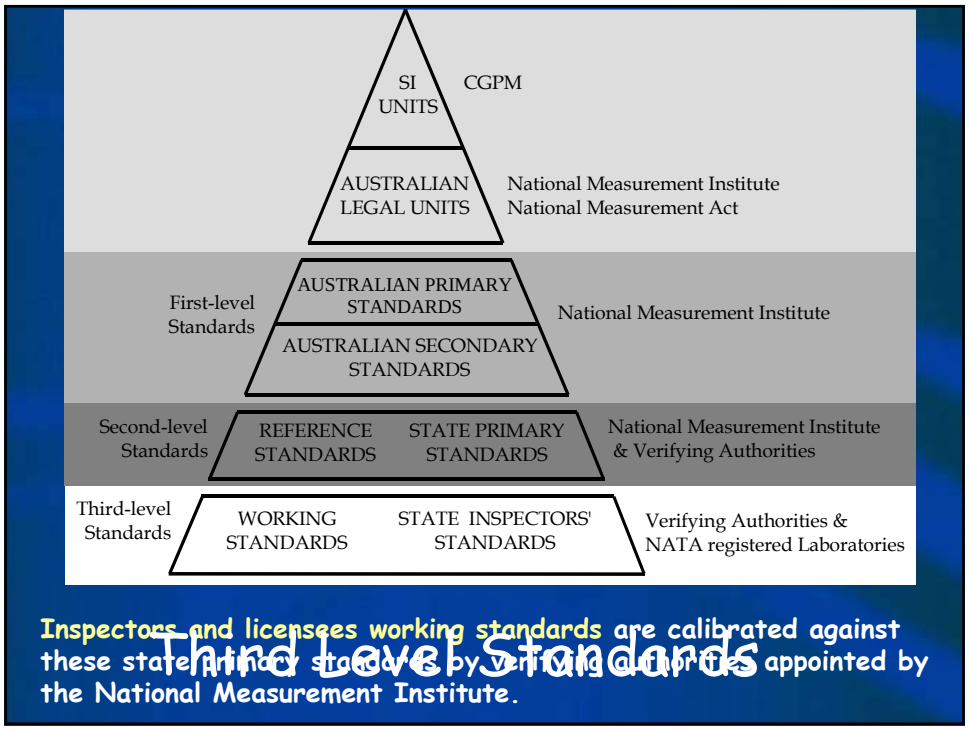


State primary standards are calibrated by the National Measurement Institute (NMI) against the primary and secondary standards.

Second Level Standards

26

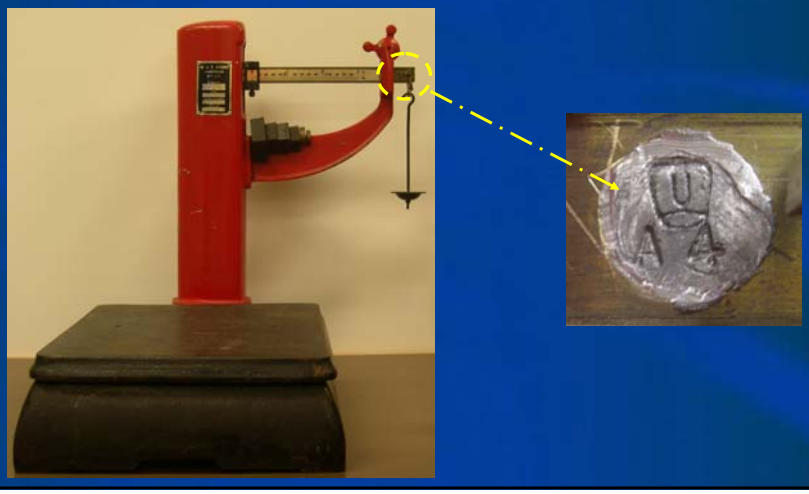


Third Level Standards

Inspectors and licensees working standards are calibrated against these state primary standards by verifying authorities appointed by the National Measurement Institute.

Verification or Certification Marks

In Australia, Trade Measurement legislation requires measuring instruments which are used for trade purposes to bear an inspector's or licensee's mark.



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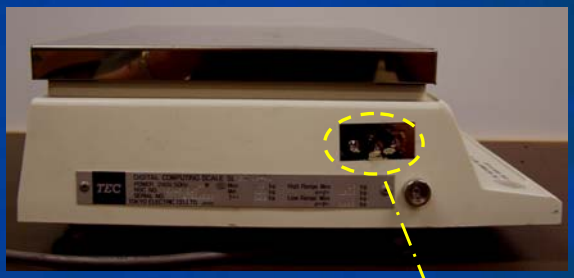
Verification or Certification Marks

In Australia, Trade Measurement legislation requires measuring instruments which are used for trade purposes to bear an inspector's or licensee's mark.



Verification or Certification Marks

In Australia, Trade Measurement legislation requires measuring instruments which are used for trade purposes to bear an inspector's or licensee's mark.

Government Crown with a unique letter or number to identify the Inspector

Verification or Certification Marks

In Australia, Trade Measurement legislation requires measuring instruments which are used for trade purposes to bear an inspector's or licensee's mark.

Letter "A" representing the month the mark was applied.

Verification or Certification Marks

In Australia, Trade Measurement legislation requires measuring instruments which are used for trade purposes to bear an inspector's or licensee's mark.

Number "4" representing the year the mark was applied

Trade Measurement

An effective trade measurement system provides significant economic benefits at a high cost/benefit ratio to the community such as:

- a level playing field for commercial transactions;
- mutual recognition of measurements used in international trade;
- ensuring full national benefit is obtained for commodity exports;
- full collection of government taxes and excise based on measurement;
- consumer protection; and
- control of fraud.

33

Protocol

Testing undertaken by Inspectors and Certifiers should be carried out in a professional, non-threatening and informative manner. Upon arrival at a traders premises you must always:

- inform the manager they are on the premises;
- identify themselves using their official identification;
- explain the purpose of the visit; and
- provide opportunities for the manager to ask questions to clarify any concerns.

34

Trade Measurement's primary role is to ensure that all transactions made by reference to measurement are fair and equitable to both the trader and the consumer.

35

36

Construction of Non-automatic Weighing Instruments

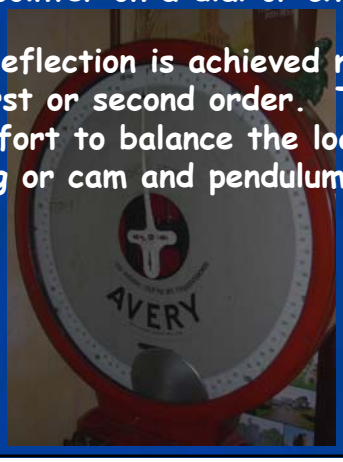
A weighing instrument, as defined in OIML R 76, is a measuring instrument that serves to determine the mass of a body by using the action of gravity on this body.

This is achieved using mechanical and/or electronic devices.

Construction of Non-automatic Weighing Instruments

Mechanical weighing instruments are principally designed as lever magnifying systems, where the relatively small deflection to the load receptor is magnified to a large deflection of a pointer on a dial or chart.

This change in deflection is achieved mostly by using levers of the first or second order. The final resistance or effort to balance the load is either by steelyard, spring or cam and pendulum mechanisms.



40

Construction of Non-automatic Weighing Instruments

Hybrid instruments are usually mechanical weighing instruments in which the analogue indicating device has been replaced by a digital indicator.

A load cell is used to change the mechanical force into an electronic signal.

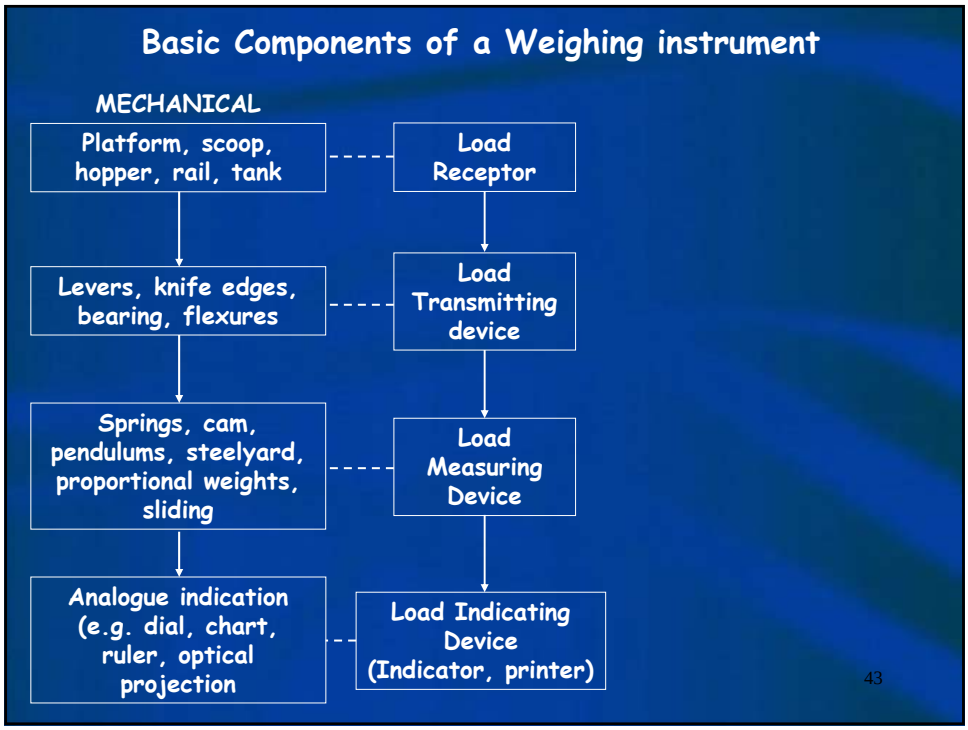
The levers in the base are connected to the load cell installed in the connecting rod. This connecting rod previously went to the analogue indicator. Hence the term 'hybrid instrument'.

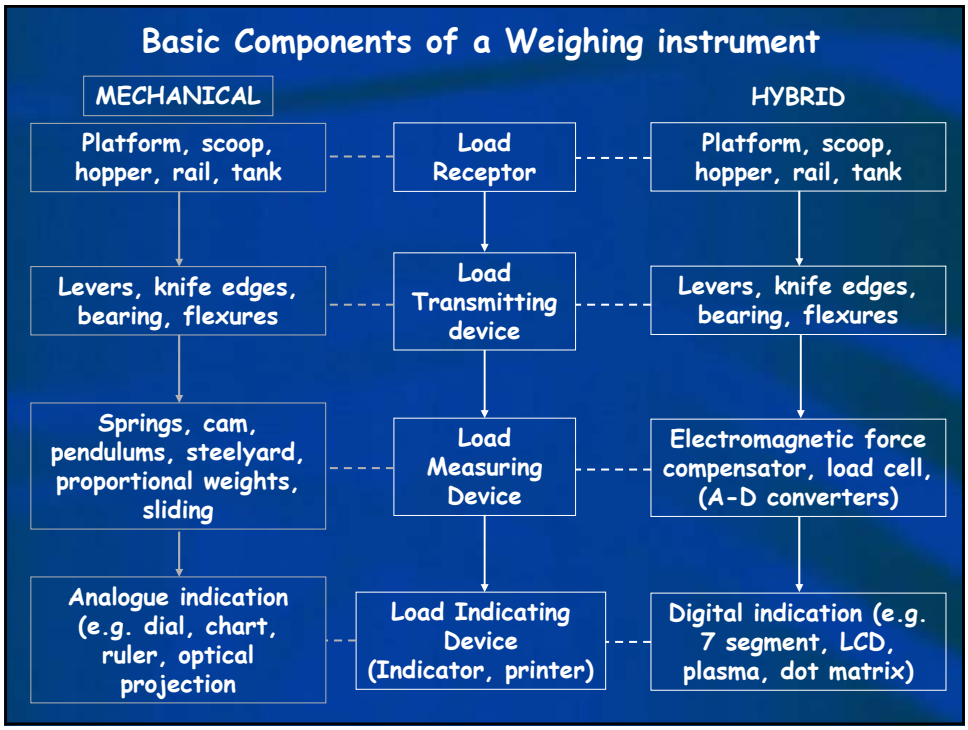
41

Construction of Non-automatic Weighing Instruments

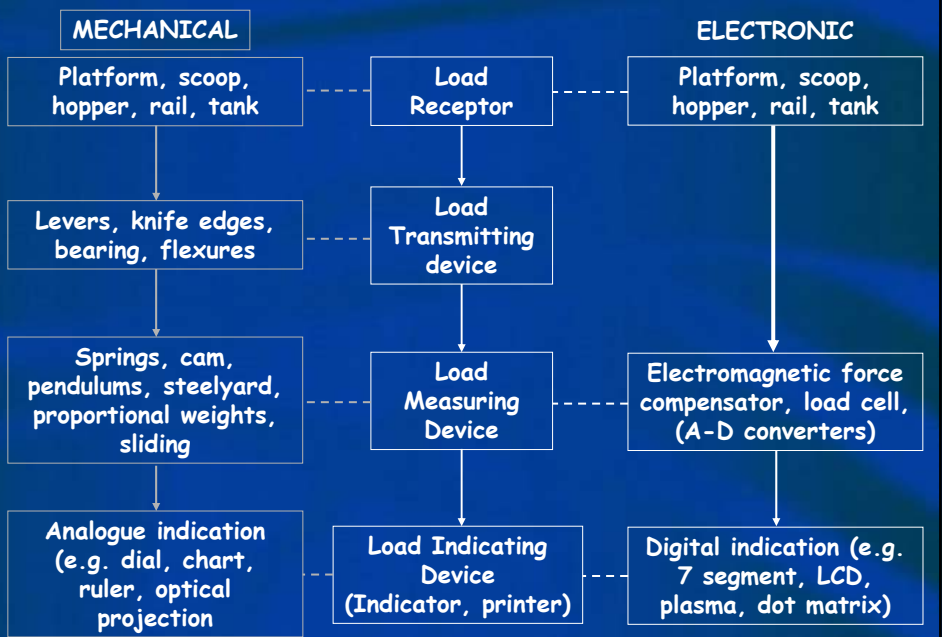
Electronic weighing instruments are those in which the load cell/s carry the load via a load receptor and a digital indicator displays the load. No mechanical levers are used. Hence the term 'full load cell instrument'.

42


Basic Components of a Weighing instrument
MECHANICAL
Platform, scoop, hopper, rail, tank
Load Receptor
Levers, knife edges, bearing, flexures
Load Transmitting device
Springs, cam, pendulums, steelyard, proportional weights, sliding
Load Measuring Device
Analogue indication (e.g. dial, chart, ruler, optical projection
Load Indicating Device (Indicator, printer)
43


Basic Components of a Weighing instrument
MECHANICAL
HYBRID
Platform, scoop, hopper, rail, tank
Load Receptor
Platform, scoop, hopper, rail, tank
Levers, knife edges, bearing, flexures
Load Transmitting device
Levers, knife edges, bearing, flexures
Springs, cam, pendulums, steelyard, proportional weights, sliding
Load Measuring Device
Electromagnetic force compensator, load cell, (A-D converters)
Analogue indication (e.g. dial, chart, ruler, optical projection
Load Indicating Device (Indicator, printer)
Digital indication (e.g. 7 segment, LCD, plasma, dot matrix)

Basic Components of a Weighing instrument



Mechanical Weighing Instruments

The most common mechanism used in the construction of mechanical weighing instruments is the lever. This can be defined as a rigid bar, which can turn about a fixed axis called the fulcrum.

The fulcrum is usually a knife-edge, which is able to pivot on a bearing. The shape of the lever may vary, as may the forces and the direction in which they act on the lever.

46

Mechanical Weighing Instruments

In general engineering practice, a lever is used to overcome a weight or load by applying a force usually called the effort.

In weighing instruments, levers are brought to a state of equilibrium or rest, the effort being merely sufficient to balance the load.

The effort resists the force of the load. In weighing the effort is called the resistant force which is used to measure the weight of the load when a state of equilibrium is reached.

47

Mechanical Weighing Instruments

The lever is used for a number of different purposes in a weighing instrument including:

- obtaining a mechanical advantage or disadvantage between the resistant and the load;
- transferring a force from one point to another;
- changing the direction of a force; and
- adding loads so that their efforts may be transferred to one common lever.

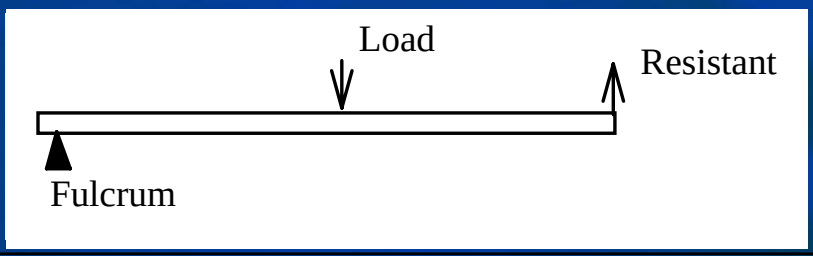
48

Mechanical Weighing Instruments

The resistant force required to reach equilibrium is controlled by the relationship between the length of the lever arm and the position of the fulcrum.

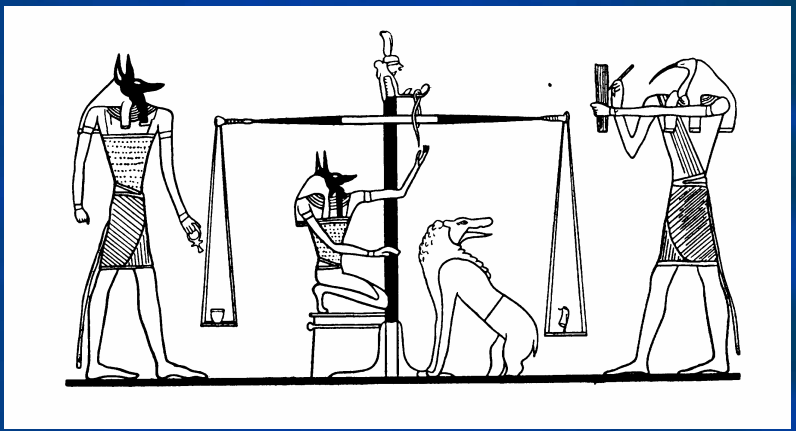
It is usual to classify levers into three groups:

- First order levers;
- Second order levers; and
- Third order levers.



Single Lever Weighing Instruments

Single lever weighing instruments are the simplest and have been used since ancient times.



50

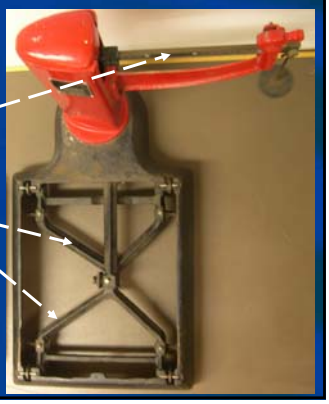
Compound Lever Weighing Instruments

Linking two or more levers together can produce a greater mechanical advantage in a more compact instrument.

These instruments are known as compound lever weighing instruments.

1st order lever

2nd order lever



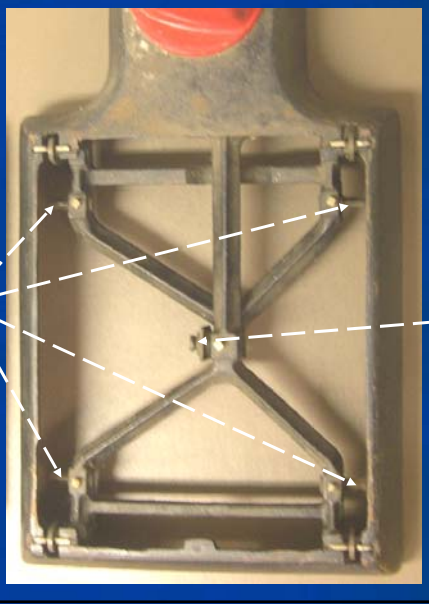
Compound Lever Weighing Instruments

The components used in this type of instrument include:

52

Compound Lever Weighing Instruments

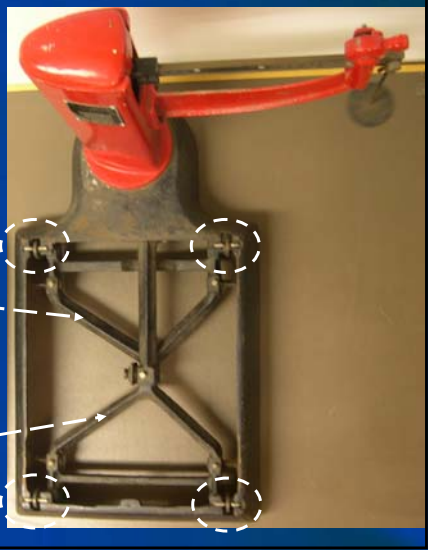
The components used in this type of instrument include:



53

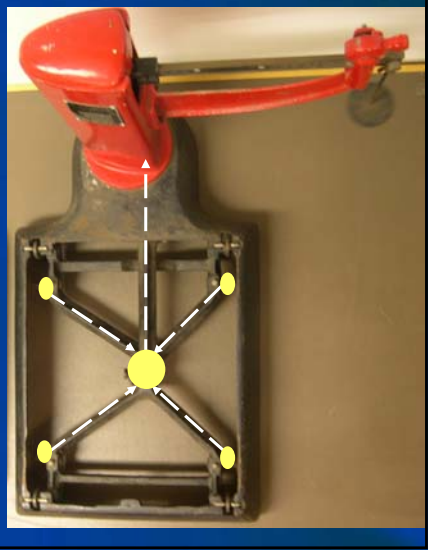
Compound Lever Weighing Instruments

In this example, two levers, the short and the long lever are suspended from the platform casing on four knife-edges and bearings.



Compound Lever Weighing Instruments

The force of the load is transferred through the central shackle to the connecting rod.



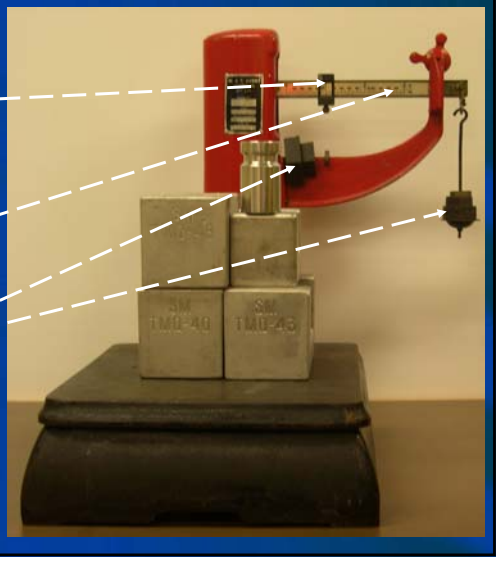
Compound Lever Weighing Instruments

The indication of the load is achieved by bringing the steelyard into equilibrium using proportional weights and the minor poise weight.

Minor poise weight

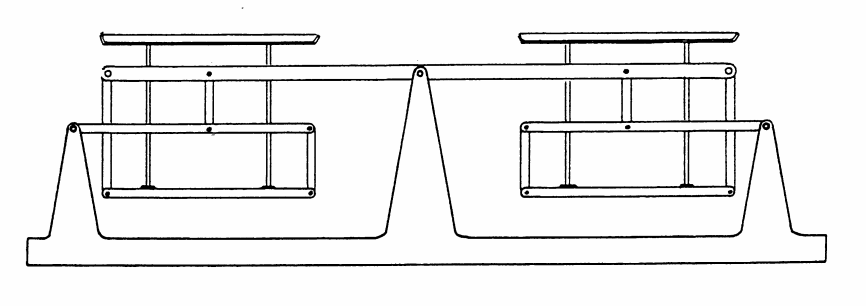
Steelyard (1st order lever)

Proportional weights



Compound Lever Weighing Instruments

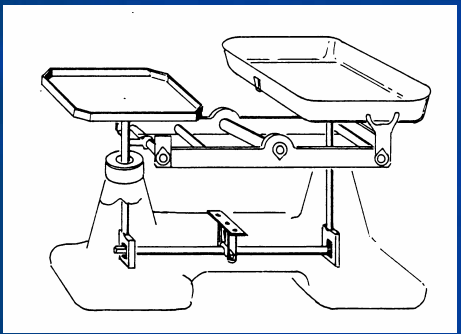
In a Beranger scale the pans are mounted above an equal-arm beam using a system of levers. This arrangement of the levers gives a large mechanical advantage.



57

Compound Lever Weighing Instruments

The Roberval scale consists of a double beam with the pans mounted above the beam. The two beams are parallel to each other with rigid cross-members connecting them together. This instrument is not as accurate as the equal arm balance. However the pans are easier to load and unload making them easier to use for trade.



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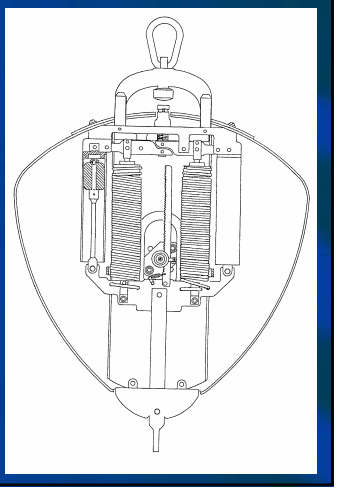
Helical or Coiled Springs

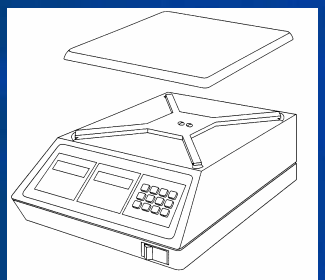
Helical or coiled springs can also be used to determine the weight of a load. This is because a helical spring will extend in a uniform way when under the strain of a load. It will then compress and return to its original size when the load is removed.

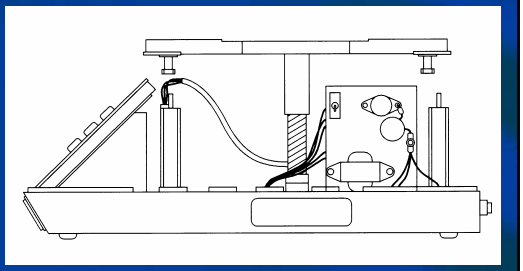
The movement of a pointer on a dial or graduated scale indicates the regular extension or compression of the spring. The vibration of the spring is often damped to allow the indicator to settle quickly so that a reading can be taken.



Electronic Weighing Instruments

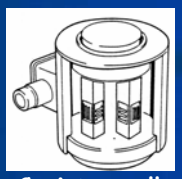
An electronic weighing instrument uses one or more load cell transducer/s to convert the mechanical force of the load being weighed into an electrical signal, which is then converted by the processor board into a mass reading which is displayed on the instrument's indicator.



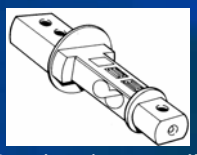


60

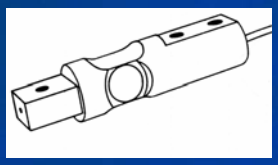
Load Cell Types



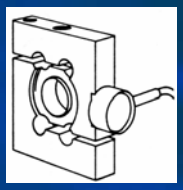
Canister cell



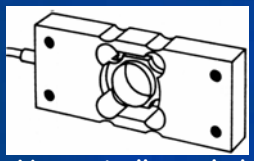
Bending beam cell



Round shear beam



S-Beam cell



Hermetically sealed packaging sensor

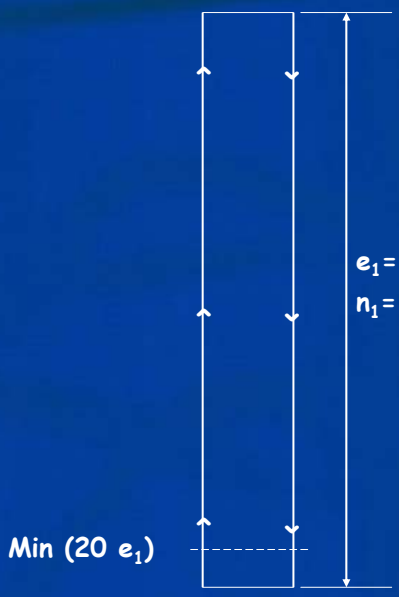
Rectangular shear beam

Electronic Weighing Instruments

Electronic weighing instruments can be designed to display the weighing result in a number of ways throughout its weighing range. For example:

- Single range;
- Multi-interval;
- Multiple range.

Single Range Instruments



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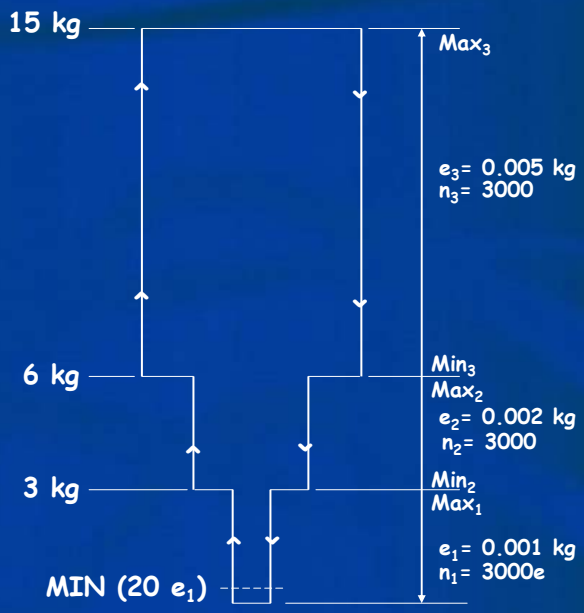
Multi-interval Instruments



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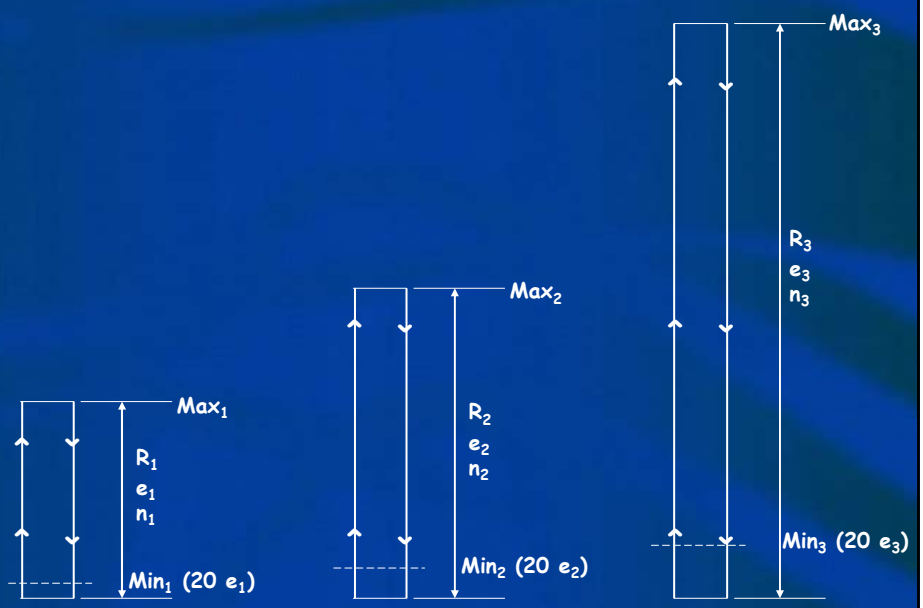
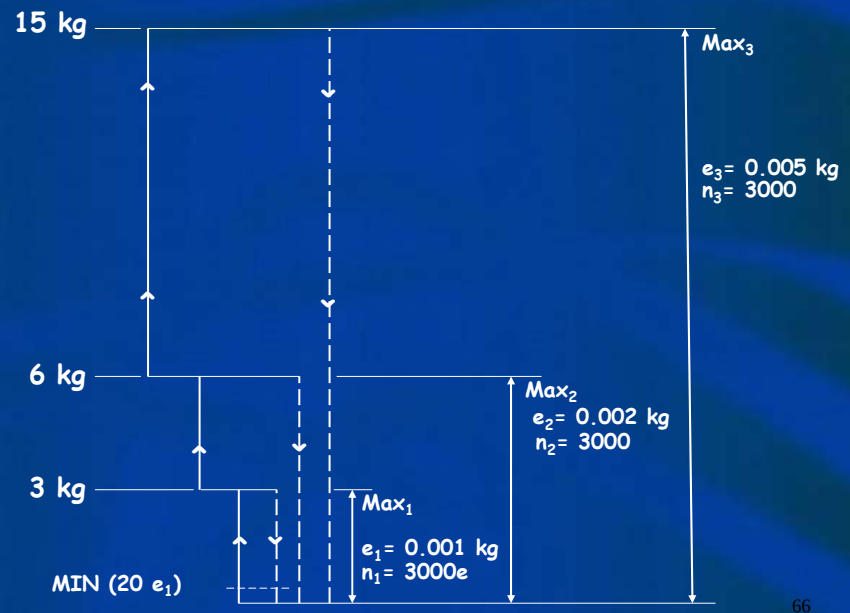
Multiple Range Instrument – Manual Change



Multiple Range Instrument – Auto Change



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Overview of

NMI V 1

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The contents of NMI V 1 includes:

Abbreviations

Explanation of Terms

1. Scope
2. Equipment
3. Visual Inspection
4. Standard Procedures
5. Test Procedures
6. Suggested Sequence for Testing

Appendix A. Test Report

Appendix B. Code of Practice for weighbridge installations

Appendix C. Worked Examples

Appendix D. Specifications for Unclassified Non-automatic Weighing Instruments

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Scope

NMI V 1 is the Uniform Test Procedures for the Verification, Certification and In-service Inspection of Non-automatic weighing instruments.

These procedures provide national uniformity and are based on international recommendations as set out in OIML R 76

In Australia the English version of OIML R 76 has been adopted as the modified national standard with the reference NMI R 76 which specifies pattern approval specifications.

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Scope continued

Application of the procedures in NMI V 1 will ensure that any non-automatic weighing instrument used for trade purposes:

- functions correctly within the maximum permissible errors;
- visually meets the requirements set out in the certificate of approval; and
- meets the requirements of the *National Measurement Act 1960.*

In addition all instruments must comply with the relevant Trade Measurement Act and Regulations.

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Scope continued

Certificates of approval are based on *NMI R 76-1. Non-automatic Weighing Instruments. Part 1: Metrological and Technical Requirements — Tests.* Refer to NMI R 76-1 for all metrological and technical requirements.

These test procedures supersede those found in *Inspectors Handbook Number 2.*

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What is a Non-automatic weighing instrument?

An instrument that requires the intervention of an operator during the weighing process;

- to deposit or remove the load from the receptor; or
- to obtain the result.

The type of instrument permits direct observation of the weighing results, either displayed or printed.

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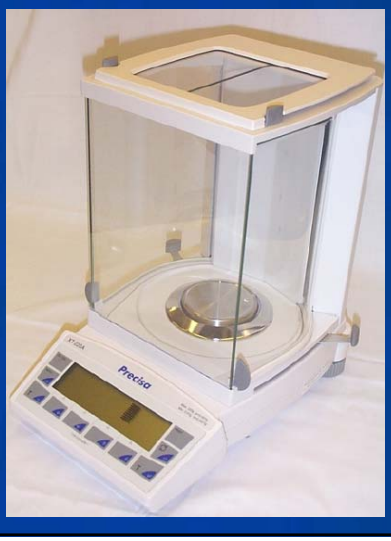
Classified non-automatic weighing instruments are classified into four classes.

Class (I) – Special accuracy



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Classified non-automatic weighing instruments are classified into four classes.

Class (II) – High accuracy

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Classified non-automatic weighing instruments are classified into four classes.

Class (III) – Medium accuracy

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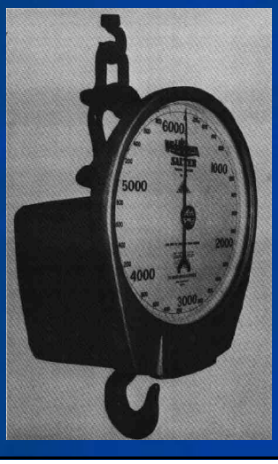
Classified non-automatic weighing instruments are classified into four classes.

Class (IIII) – Ordinary accuracy



Thank you for taking the time to complete this training module.

Please remember to provide us with your feedback.

If you have any questions or suggestions email marian.haire@measurement.gov.au or your trainer

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