Infrastructure Commission (INFCOM)

Standing Committee on Measurements, Instrumentation and Traceability (SC-MINT)

Expert Team on Quality, Traceability and Calibration (ET-QTC)

Calibration of Pressure Instruments

Part-2: Methods of Measurement

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Part 1:

- Introduction to this topic and historical information
- Concepts and definitions

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- Calibration equipment and data acquisition

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Methods of measurement

- this unit considers the following types of pressure sensors

- electronic barometers with
  - analogue output (e.g. 500…1100 hPa ⇒ 0…2,5 V) and
  - digital output (e.g. RS232)

Such a device serves as an example in the part 2!

- mechanical barometers
  - aneroid barometers
  - barographs

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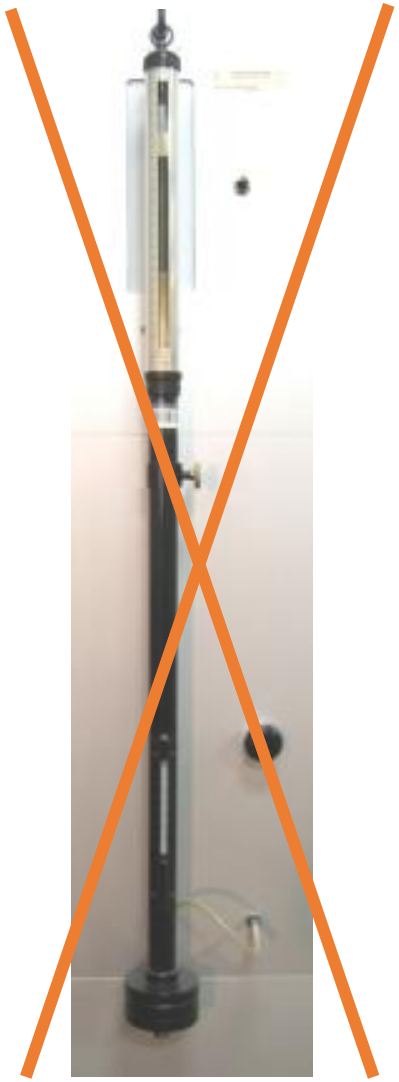
Methods of measurement

- Mercury barometers, which fall under the regulation of the Minamata Convention, are not within the scope of this unit.

- Due to the hazardous nature of mercury for humans and the environment, mercury barometers should not be used anymore.

https://www.mercuryconvention.org/en

https://en.wikipedia.org/wiki/Minamata_Convention_on_Mercury



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Methods of measurement

Some notes to mechanical barometers

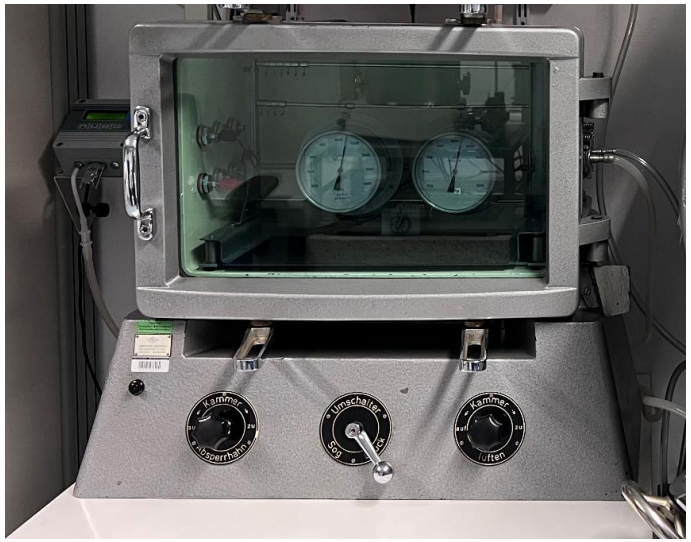
- due to the mechanical transmission linkage, precision is lacking
  - significantly higher hysteresis,
  - the repeatability is significantly lower and
  - the resolution is generally low (0.5 or 1 hPa)

Methods of measurement

- maintenance and adjustment is difficult
- temperature compensation is very difficult
- they have a backlash (play, slope) problem due to the mechanism, and need some appropriate light tapping or vibration before any reading
- with barographs there is also the problem that the paper changes with temperature and humidity, so that the scaling will change
- a daily adjustment is required for barographs

Methods of measurement

- and in most cases you need a pressure chamber (necessary if no pressure port on barometer)
- pressure change causes temperature change and thus the stabilization process takes much longer
- the reading is taken through a glass pane
- the measured values can possibly only be recorded manually



Requirements for the laboratory setup

- due to the low resolution, the repeated reading of the measured values does not bring any advantages with regard to statistical values (type A)

Conclusion:

- barographs are dedicated to the determination of a pressure tendency
- and all mechanical measuring devices can never achieve the low measurement uncertainties of modern electronic devices
- it is recommended to replace mechanical measuring instruments with modern electronic measuring instruments

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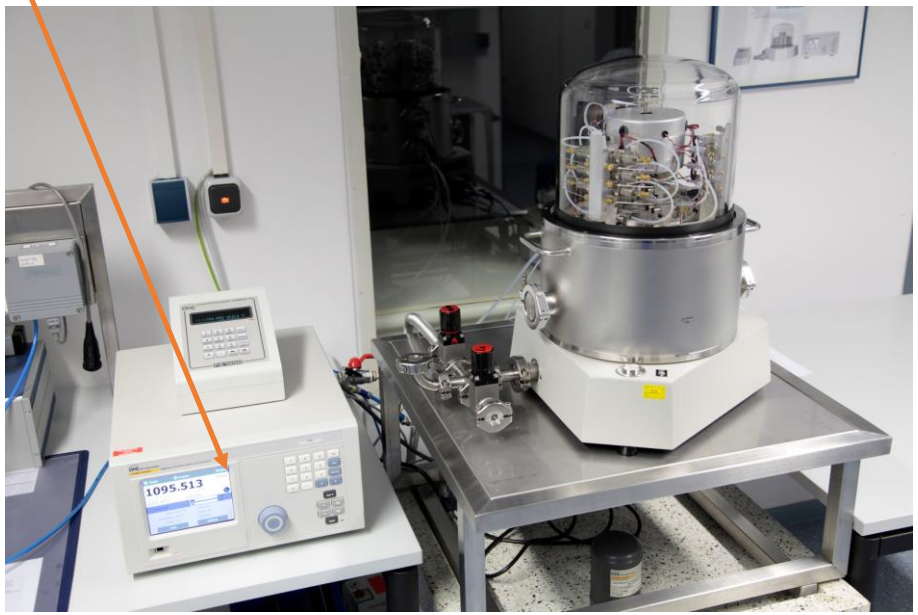
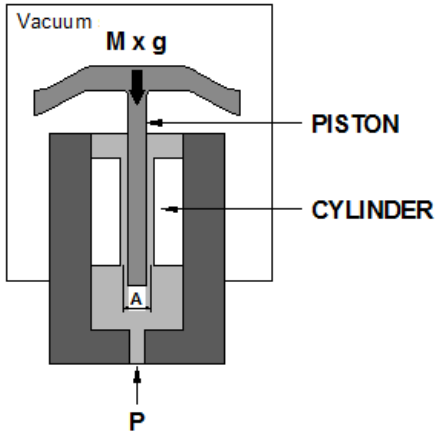
Pressure standards in calibration laboratory

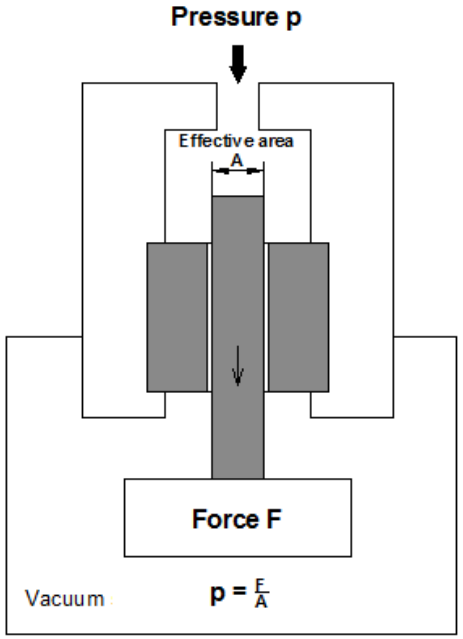
- two types of standards are common:
  - absolute pressure controllers



Pressure standards in calibration laboratory

- and piston gauges (primary standards)
  - the generated pressure is in balance with the weight of loaded mass
  - piston gauges with a dynamometer (they measure force, pressure is calculated)





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Pressure standards in calibration laboratory

- Absolute pressure controllers:
  - connected to pressure generator (mostly pumps or nitrogen bottles)
  - connected to vacuum supply (mostly pumps)
  - internal reference pressure sensor(s)/gauge(s) or external reference pressure gauge(s)
  - **two** pressure sensors should be used, **one** internal **to control pressure generation**, the other (internal or external) as the **pressure standard / standard barometer (SB)**

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Pressure standards in calibration laboratory

- direct connection to the DUTs

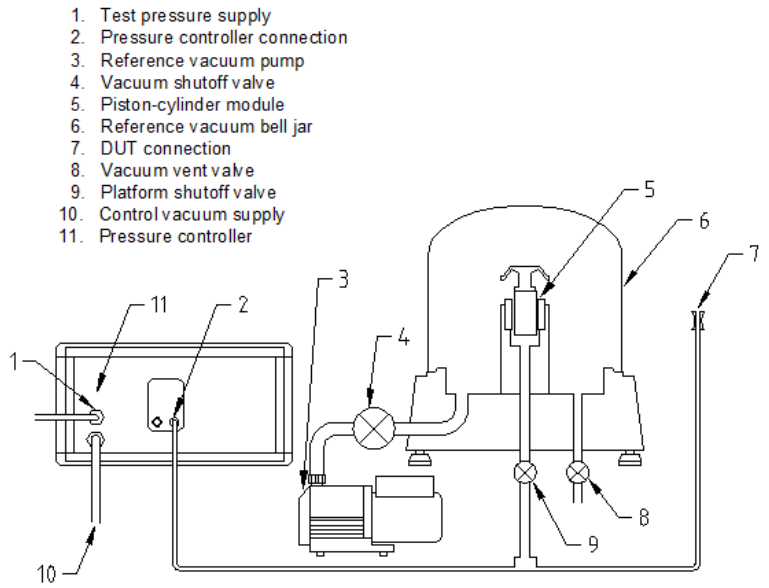
- pros: easy to handle, easy to use, wide range, transportable, automatic mode, fast, reliable and stable if well cared

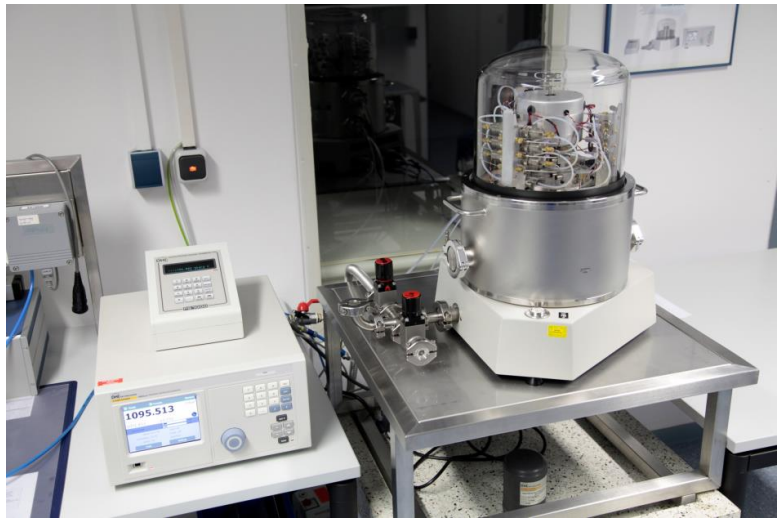
- cons: an annual calibration is recommended for the reference pressure gauge (internal or external), the controller itself **shall be characterized** regularly (typically every two years), equipment very sensitive to overpressure (set measures to avoid any absolutely), sensitive to pollutants (water, salt, fumes…)

Pressure standards in calibration laboratory

Fundamental piston gauges:

- primary standard with very good long-term stability
- need of very dry and clean test pressure
- not easy to handle, they shall be disassembled for transport
- in absolute mode a vacuum gauge is needed for measuring of the residual pressure





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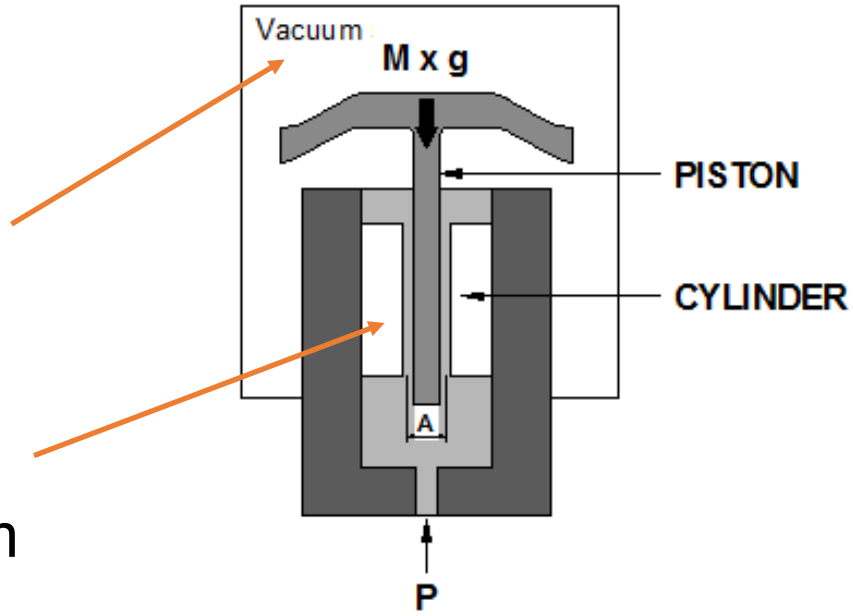
Pressure standards in calibration laboratory

- in automatic mode fast with a minimum need of manpower
- in manual mode every point needs a lot of time and manpower (creating the vacuum, changing the masses shall be double-checked)
- due to the limited resolution of the weights pressure generation only in steps
  - for example, 995 hPa, 1005 hPa, 1015 hPa if an automatic mass handling system is used
- they are not designed to work with pressure chambers

Pressure standards in calibration laboratory

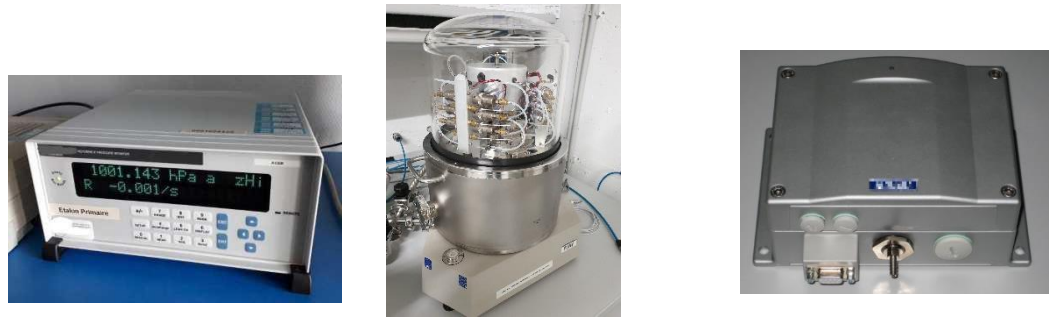
- a pressure controller must be used as an additional device
- a vacuum pump is necessary in absolute pressure mode
- the temperature of the piston-cylinder system shall be measured

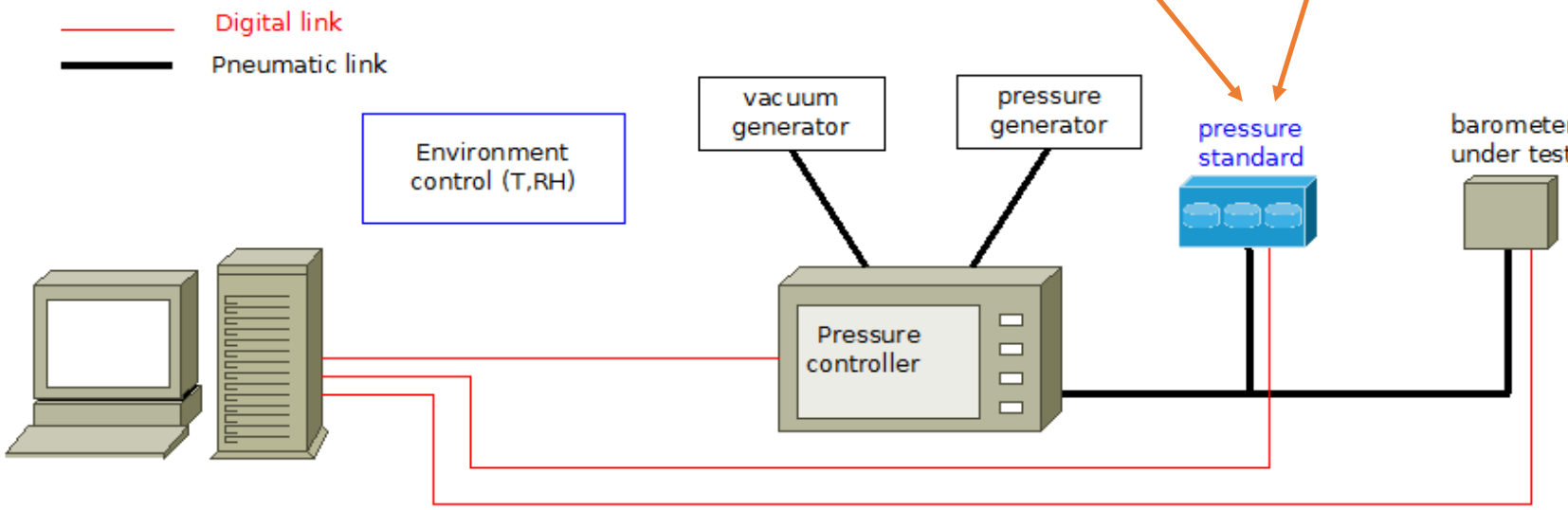


Requirements for the laboratory setup

- typical layout for calibration of digital barometers with a pressure controller in a laboratory

- in case of an analogue output, an additional instrument such as a multimeter for data acquisition is needed





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Requirements for the laboratory setup

- the environmental conditions shall be controlled, observed and recorded
  - air temperature should ideally not change by more than +/- 1K during the entire calibration
  - the influence of the temperature span during calibration shall be taken into account

Calibration of Pressure Instruments
End of Part 2

Thank you.

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