

Negative gauge pressure comparison 2016

1 Introduction

Negative gauge pressures are a common range for pressure calibrations although uncertainty requirements in this range are not generally very high. Results from earlier comparison (EURAMET.M.P-S9 Loop 2) in the range -95 kPa to 0 kPa showed CEM had problems in its capabilities in that range. A new comparison will now be performed with LNE as the reference (as LNE was the pilot in the previous comparison for loop 2) to demonstrate that CEM has solved its problems in that range.

2 Responsibilities

LNE is responsible for preparing the measurement instructions and CEM is responsible for controlling the stability of the transfer standard and calculating the results. The final report of this comparison will be drafted together by CEM and LNE.

3 Transfer standard

3.1 Identification

The transfer standard is a pressure monitor RPM4 A160Ks, serial No. 563, operating with nitrogen. It has a resolution of 0,1 Pa. The manufacturer is DHInstruments, Inc.

3.2 Operating principle

The manometer is composed of an absolute Quartz Reference Pressure Transducer (Q-RPT) and of an internal barometer.

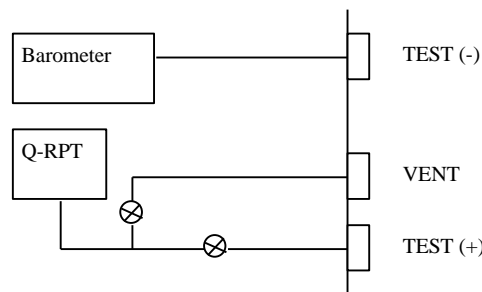


Figure 1 RPM4 pneumatic schematics

The negative pressure indicated by the RPM4 at the instant t , $P_{RPM}(t)$, is expressed by the following equation:

$$P_{RPM}(t) = P_Q(t) - P_Q(0) + P_{baro}(t) - P_{baro}(0) \quad (1)$$

Where

$P_Q(t)$ Indication of the Q-RPT absolute pressure at the instant t

$P_Q(0)$ Indication of the Q-RPT at the atmospheric pressure at the time of AutoZ execution

$P_{\text{baro}}(0)$ Indication of the barometer at the atmospheric pressure, at the time of AutoZ execution

$P_{\text{baro}}(t)$ Indication of the barometer at the atmospheric pressure, at the instant t .

3.3 Acquisition

Each participant can make the acquisition in manual or automated by commands from a remote computer.

3.4 Manual acquisition

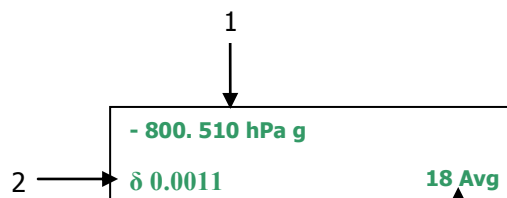
The **average** DISPLAY should be active. Please check the averaging time period is 30 seconds.

If the average DISPLAY is not active, you have to activate it and adjust the period of time:

1. To access the Average DISPLAY, press [DISPLAY], <1Avg>.
2. Edit the averaging time period, 30 s.

Averaging Period:
30 s

3. Press [ENT] and returns to the main run
4. The Average DISPLAY is active the main run screen is:



1. Average measured over the last completed averaging period.
2. Standard deviation of the last completed averaging period.
3. Countdown in seconds until completion of ongoing averaging period.

3.4.1 Remote acquisition

Please consult RPM4 manual for remote operations. The menus usually accessed from the front panel are locked out while in remote mode.

If you make the acquisition via the port RS232, the configuration parameters are described below (please don't change this configuration):

Baud Rate	:	9200 à 19200
Parity	:	EVEN
Data bits	:	7
Stop Bit	:	1

4 Transportation

For transportation, the instrument is packed in an aluminium case. A courier service or post can be used for transportation. Hand-carrying is not necessary.

Immediately after receipt, the participating institute shall check for any damage of the standard, in particular scratches and rust, and report this to the other participant. In the case of failure, the transfer package shall be returned to the LNE for inspection.

CEM is responsible for the transportation costs of the comparison.

5 Measurements

5.1 Installation procedure of the transfer standard

- 1- Please ensure that the T.S. will always be isolated from pressures out of its operating range -950 - +600 hPa.
- 2- Connect the manometer to the 230 VA sector, switch on the device and wait for the initialisation.
- 3- Configure the transfer standard in « GAUGE » mode, press the **[MODE]** function key and select **<gauge>** mode.
- 4- Connect together the TEST(+) port with the port TEST(-) and run AutoZ, press **[AutoZ]**. The value indicated should be zero (± 1 Pa)

- 5- **Leave unobstructed the TEST(-) port** or connect it to the reference standard's port if available. The reference pressure should be within [950hPa - 1050 hPa].
- 6- Before connecting your pressure standard, please ensure that its pneumatic circuits are at atmospheric pressure.
- 7- Finally, connect your pressure standard output to the TEST(+) port. The port VENT must be always opened to the atmosphere.
- 8- If the message «SDS closed» is flashing, please press the button « SDS » and then answer « YES » to the question « Defeat SDS ». The opening of the SDS will limit the damages in case of overpressure. In any case of overpressure, contact the pilot laboratory.

5.2 Measurements

After temperature stabilisation of the T.S. at 20°C for at least 12 hours, each participant carry out a calibration in an ascending, and then descending sequence of 6 pressure points, which is defined by their nominal gauge pressures:

0 kPa, -200 hPa, -400 hPa, -600 hPa, -800 hPa, -950 hPa

The reference pressures should be within the nominal pressures ± 5 hPa.

Note the atmospheric pressure at the beginning and the end of each cycle.

At each pressure point, after 1-minute stabilisation, the readings of the transfer are recorded during 30 seconds (see section 5.3 acquisition).

The whole procedure (the ascending and then the descending procedure) is repeated **3 times**:

1. Zero the pressure module: connect together the TEST(+) port with the port TEST(-) and running AutoZ.
2. Feed the pressure from your laboratory standard to the transfer instrument and record the readings at nominal gauge pressures 0 hPa, -200 hPa, -400 hPa, -600 hPa, -800 hPa and -950 hPa. Do not come back to zero pressure between the points; if necessary use the attached ball valve to separate the transfer standard when preparing the next nominal pressure.

3. Apply pressure $-950 \text{ hPa} \pm 5 \text{ hPa}$ for approximately 3 to 5 minutes.
4. Feed the pressure from your laboratory standard to the transfer instrument and record the readings at nominal gauge pressures -950 hPa , -800 hPa , -600 hPa , -400 hPa , -200 hPa and 0 hPa . (The results in increasing and decreasing direction of pressure will be treated separately to minimise hysteresis effects.)
5. Wait for 3 to 5 minutes with the pressure module at atmospheric pressure and zero the pressure module again.
6. Repeat the steps 2 to 5 at least two times to get three results at each nominal pressure both with increasing and decreasing pressures.

The calibration is performed with nitrogen only.

Do not come back to zero pressure between the pressure points.

Do not make any other adjustments on the device before or after your measurements.

6. Circulation scheme

The agenda of the calibration is given in Table 2. A participant who can foresee that the calibration cannot be carried out on time must discuss this with the other participant.

Laboratory	Scheduled time
CEM 1 st	Week 1/2016 (January)
LNE	Week 3/2016 (January)
CEM 2 nd	Week 5/2016 (February)

7. Report:

CEM will send its results to LNE (Pierre.Otal@lne.fr) so that LNE can perform the calculation for comparison evaluation. Attached to this protocol there are copies of the Excel table, which have to be filled out electronically. The electronic tables are only sent by e-mail. All measured data must be sent as an Excel table ([Results file.xls](#)).

All values shall be given with so many significant digits as reasonable according to your measurement uncertainties. Uncertainties shall be given with two significant

digits and should cover the value's final digit. Uncertainties shall be given as standard uncertainty ($k=1$) according to JCGM 100:2008.

In the following, all information that must be sent to the pilot laboratory is listed and, if necessary explained.

- 1) A short description of your standard.
- 2) A detailed description of how the measurements were performed (general procedure, a schematic of the experimental set-up, the duration of the temperature stabilisation at $(20 \pm 1) ^\circ\text{C}$ etc.).
- 3) Date of receipt of the transfer standards in your institution.
- 4) Notes of inspection of the package (e.g. Damages? Completeness?).
- 5) Complete data set in an Excel file according to the form as attached.

LNE will draft the report and send it for comments and/or approval to CEM.

Contact data of participating laboratories

Laboratory	Contact Person	Phone	E-mail
Centro Español de Metrología (CEM) Alfar, 2 Tres Cantos ES-28019 Madrid Spain	Nieves Medina Salustiano Ruiz	+34 91 80 74 789/792 +34 91 80 74 807	mnmedina@cem.minetur.es sruiz@cem.minetur.es
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