Operating Manual
for

Deadweight Tester
(Pressure Balance)

Type CPB5000-HP

High Pressure Models

DRUCK & TEMPERATUR Leitenberger GmbH
Bahnhofstr. 33 • D-72138 Kirchentellinsfurt • Germany
Tel.: +49-7121-90920-0 • Fax: +49-7121-90920-99
E-Mail: DT-Export@Leitenberger.de • http://www.Leitenberger.com

Contents:

DRUCK & TEMPERATUR Leitenberger GmbH
Bahnhofstr. 33 • D-72138 Kirchentellinsfurt • Germany
Tel.: +49-7121-90920-0 • Fax: +49-7121-90920-99
E-Mail: DT-Export@Leitenberger.de • http://www.Leitenberger.com

1. General Notes

In this operating manual you get all necessary information for the operation of the Deadweight Tester CPB5000.
For further information, or in case of problems, please contact your dealer.

The deadweight tester CPB5000 is - if not stated contrary - calibrated according international norms and rules and traceable to a national pressure standard.

The warranty period of the deadweight tester CPB5000 is 24 months after date of shipment, acc. to our payment and shipment terms. There is no warranty in case of ignoring this operation manual and in case of wrong handling of the unit.

2. Description of Deadweight Tester

2.1 Basic principles of deadweight tester (pressure balance)

Deadweight Testers are the primary standard for pressure measurement. Utilising the well-proven piston system, consisting of a vertically mounted precision plapped piston and cylinder assembly, accurately calibrated weight masses (force) are loaded on the piston (area) which rises freely within its cylinder. These weights balance the upward force created by the pressure within the system.

$$\mathrm{Pr}\,essure = \frac{Force}{Area}$$

2.2 Influencing factors

The deadweight tester is calibrated according to nominal standards (or customers specification). If there are differences between the calibrated conditions and the real conditions “on site”, correction calculations have to be made. Following influencing factors have to be considered:

2.2.1 Local gravity

Gravity varies greatly with geographic location, and so will the Deadweight Tester reading. Due to the significant change in gravity throughout the world (up to 0.5%), ensure that the Deadweight Tester has either been manufactured to your local gravity, or that you have applied the correction from the calibrated gravity.

$$True\,\mathrm{Pr}essure = Nominal\ pressure \bullet \frac{LocalGravity}{CalibratedGravity}$$

Example: Calibrated gravity of the supplied Deadweight Tester: 9.806650 m/s² (*g Norm*)
Your local gravity: 9.811053 m/s² (*g Local*)

Nominal pressure: 100 bar

True Pressure: $p = p_{Nominal} \frac{g_{lokal}}{g_{Norm}} = 100bar \frac{9{,}81105}{9{,}80665} = 100{,}0449bar$

Without correction you would heave a reading error of 0.05%.
*NOTE: With the **Intelligent Kalibration-Module Type IKM** the calculation for correction can be automatized.*

2.2.2 Temperature at the piston-/cylinder-system

The effective area of the piston depends on the temperature. This influence depends on the used material of the piston and is expressed as the Temperature Coefficient (TK). The deadweight tester is typically calibrated for a piston-/cylinder-temperature of +20˚C. If you measure another temperature, a correction has to be calculated as follows:

$$True\,\mathrm{Pr}essure = Nominal\ Pressure \bullet \frac{1}{(1 + (t_{measured} - t_{calibrated}) \bullet TK)}$$

Example: Calibrated temperature: 20˚C
Measured temperature: 23˚C
TK: 0,0022%

$$True\,\mathrm{Pr}essure = 100bar \bullet \frac{1}{(1 + (23 - 20) \bullet 2{,}2^{-5})} = 99{,}99340bar$$

Without correction you would have a reading error of 0.007%.
*NOTE: With the **Intelligent Kalibration-Module Type IKM** the calculation for correction can be automatized.*

2.2.3 Ambiend conditions

Temperature and Air Density variations are less siginificant, variations should be corrected for when maximum accuracy is required.

$$Mass = NominalMass \bullet (1 - \frac{AirDensity}{MassDensity})$$

The Air Density is typically 1.2 kg/m³ (at nominal conditions 20˚C / 40% r.h. / 1030 hPa)
The density of the masses (non-magnetic steel) is 7960 kg/m³, of the aluminium masses 2700 kg/m³.

If the Air Density differs about 5%, an additional reading error of about 0.001% happens.
*NOTE: With the **Intelligent Kalibration-Module Type IKM** the calculation for correction can be automatized.*

2.2.4 Effective area of the piston

At higher pressures (appr. >1000 bar) the effective area of the piston is changing due to the pressure force. This dependency is expressed as “pressure distortion coefficient” (λ).
The pressure distortion coefficient (λ) of your Deadweight Tester is stated on the calibration certificate.

$$True\ Pressure = Nominal\ Pressure : (1 + \lambda \bullet Nominal\ Pressure)$$

Example: Check point: 1000 bar

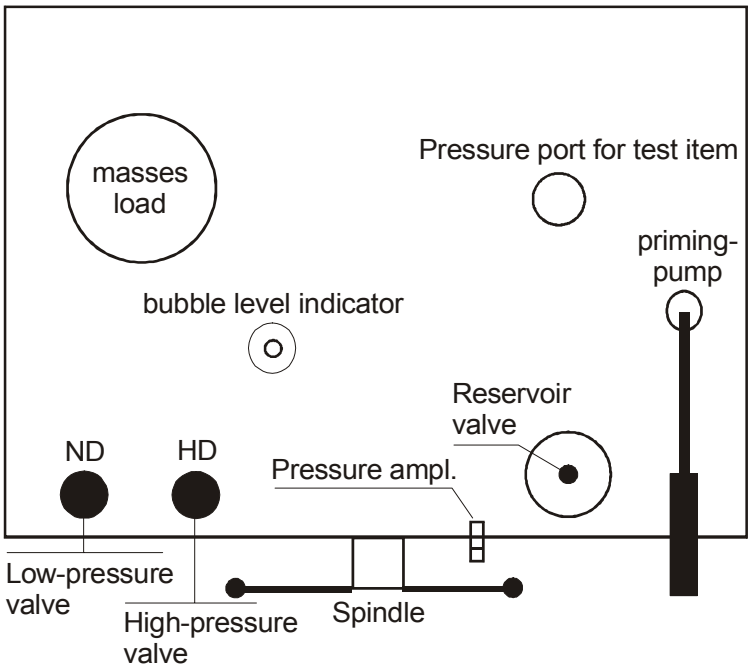
Pressure distortion coefficient: 10^{-7} 1/bar

$$True\ Pressure = 1000 : (1 + 1 \bullet 10^{-7} \bullet 1000)\ bar = 999.90\ bar$$

Without correction you would have a reading error of 0.01%.
*NOTE: With the **Intelligent Kalibration-Module Type IKM** the calculation for correction can be automatized.*

HINT:
The ***Intelligent Kalibration-Module Type IKM*** is available as an accessorie - see page 11.

2.3 Operating controls



WARNING:

- **Never open the low-pressure-valve (ND) if the high-pressure-valve (HD) is open!**
- **Never open the low-pressure-valve (ND) if the system is pressurized >1000 bar!**

3. Implementation and Operation

3.1 Preparation

3.1.1 Placing the deadweight tester

- Place the Deadweight Tester on a rigid surface. Avoid an unsafe stand and vibrations. This could cause misreading of the measured values.
- If there is no air-conditioned room available, please place the Deadweight Tester not close to the heating system and not close to windows to avoid or minimize incident solar radiation and air flow.
- The bubble level indicator shows the right positioning of the Deadweight Tester. Please use the adjustable feet of the Deadweight Tester, the air bubble must be centered.
- Please check wether the oil reservoir is filled with appr. 200-250 ml special operating fluid which is supplied with the Deadweight Tester (1 Litre bottle). Do never use other fluids for operation.
- Attach the handle to the spindle pump.

3.1.2 First implementation

At first implementation the system must be bleeded, as follows:

- open the low-pressure-valve (ND)
- close the high-pressure-valve (HD)
- close the reservoir valve
- turn the spindle fully anticlock-wise
- Operate the priming pump carefully 2-3 times, until the operating fluid becomes visible at the pressure port for the unit under test.

3.1.3 Connecting the unit under test

The Deadweight Tester is fitted with a high pressure connection M20 x 1.5 female. Mount the unit under test using adequate seals.

3.1.4 Basic position of the vents

- Low-pressure-valve (ND): OPEN
- High-pressure-valve (HD): CLOSE
- Reservoir valve: CLOSE

Now you can calibrate with your Deadweight Tester.

3.2 Operation

3.2.1 Placing masses (weights)

The ball-shaped protection of the piston and the piston itself have a basic weight equal to appr. 20 bar (see certificate). The Deadweight Tester is supplied with a complete set of calibrated weights.

- Place the weightes (masses) which corresponds to the requested pressure (see certificate) on the weight-bell. Start with the largest ones and place the smaller ones on top to get a low balance point.
- All pieces of weights are marked with a number, corresponding to the supplied calibration certificate and the serial number of instrument.
- The reached pressure is equal to the sum of the pieces of weights (and piston).
- For an easy calculation of needed weights we suggest to use our optional “Intelligent Calibration Module IKM”.

3.2.2 Achieving test point at increasing pressure

- Make sure that the valves are in the “basic position” as described in Chapter 3.1.4, page 7
- Operate the priming pump until a pressure of about 60 bar (**max. 100 bar**) is reached.
- Turn the spindle clock-wise until the requested test pressure is reached (max. 1000 bar!)

If the requested pressure is > 1000 bar:

- At appr. 850 bar the integrated pressure amplifier (4:1) must be operated:
  1st: close the low-pressure-valve (ND)
  2nd: open the high-pressure-valve (HD)

.

ATTENTION: never open both valves at the same time!

- Turn the spindle clock-wise.
- If the spindle is at the dead stop, follow this procedure:
  - close the high-pressure-valve (HD) and keep low-pressure-valve (ND) closed
  - open the reservoir valve
  - turn spindle fully anticlock-wise
  - close reservoir valve
  - operate priming pump 2-3 times
  - open high-pressure-valve (HD) and keep low-pressure-valve (ND) closed)
- Turn spindle clockwise to increase the pressure up to the requested test point.

Turn the spindle pump sensitive clockwise to increase the pressure until there is a balance between pressure and the placed weights and the stack of weights is floating.

When the test point (balance point) is reached and the stack of weights is floating at the right level, initiate the weights with your hand to let them rotate (not too fast) clockwise.

The piston (and this means, the pressure) remains stable for several minutes. Use this time to read the value from your unit under test, make adjustments at your unit under test, etc.

3.2.3 Achieving test point at decreasing pressure

To decrease the pressure, follow this procedure:

- Turn spindle fully anti-clockwise (max. to the dead stop)

If the requested pressure is below 1000 bar:

- Close the high-pressure-valve (HD)
- Open the reservoir valve
- Turn spindle fully clockwise
- Close reservoir valve
- Operate the priming pump 2-3 times
- Open the high-pressure-valve (HD)
- Turn the spindle anti-clockwise until requested test point is reached

- Turn the spindle anti-clockwise until pressure decreased <1000 bar.
- Close high-pressure-valve (HD)
- Open low-pressure-valve (ND)
- Turn the spindle anti-clockwise until requested test point is reached.

Going back to zero pressure when calibration is finished:

- Turn spindle fully anti-clockwise
- Open reservoir valve

3.3 Disassembly

- Dismount the unit under test from the test port
- Reset the system to the “basic position”, see Chapter 3.1.4, page 7
- Protect the basement with the protective cover (textile, blue color)

4. Maintenance

4.1 Cleaning the masses (weights)

- The weights should be handles with clean gloves only.
- If necessary, clean the weights with pure alcohol (spirit).

4.2 Recalibration

The recommended cycle for re-calibration is 5 years. This is a recommendation of the DKD (Deutscher Kalibrier-Dienst / German Calibration Service), assumed that you take care in operating and handling of the Deadweight Tester and the weights.
Rude cunditions (dirty or dammaged weights) should result in shorter re-calibration cycles, e.g. 3 years or 12 months.

As a result of a recalibration you get a traceable factory calibration certificate or a DKD certificate.
Please contact

DRUCK & TEMPERATUR Leitenberger GmbH
Service & Calibration Department
Bahnhofstr. 33
72138 Kirchentellinsfurt
GERMANY
Tel. +49 - 71 21 - 9 09 20 - 0
Fax +49 - 71 21 - 9 09 20 - 99
E-Mail: DT-Export@Leitenberger.de

5. Type Overview and Accessories

5.1 Types and available pressure ranges

Range in bar	Execution	needed masses in kg	Accuracy 1) in % of reading	smallest pressure step *)
0.03...2	**Pneumatic** (suitable for clean dry air or nitrogen - other on request)	10	**0.015** 1) The accuracy is characterised by the deviation of span, which is the sum of the systematic error and the uncertainties of measurement. Longterm stability is not taken into account. Please note that corrections might be required if the instrument is used without the Intelligent Calibration Module IKM. As an option, an accuracy of ±0.015% is available	0.01 bar
0.2...10		10		0.05 bar
0.4...50		10		0.25 bar
0.4...100		20		0.25 bar
0.2...60	**Hydraulic** (suitable for special oil - included in standard supply - other media on request)	30		0.1 bar
0.2...100		50		0.1 bar
5...250		25		0.4 bar
5...400		40		1 bar
5...600		30		1 bar
5...1000		50		1 bar
25...2500		**50**	**0.025** (Optional: 0.020)	
25...4000		**80**		

*)without optional trim masses

5.2 Optional accessories

5.2.1 Intelligent Calibration Module IKM:

Especially when highly accurate measuring values with uncertainties of measurement of less than 0.025 % are required, complicated mathematic calculations and corrections used to be necessary. With this optional addition to the system all critical ambient parameters are registered and automatically corrected. Furthermore a calibrator function for pressure transmitters is integrated, so that a voltage can be supplied to the sensors and sensor output signals can be measured without any problem. No additional devices are required for that purpose.

5.2.2 other optional accessories:

- Set of trim masses (weights 2 mg to 100 g)