



Calibration Certificate

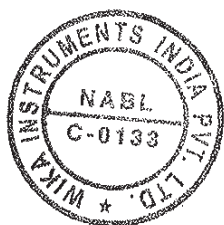
Calibration mark

WD14-010

2014-03

Object	Dead weight tester	This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).
Manufacturer	Pressurements	The user is obliged to have the object recalibrated at appropriate intervals.
Type	M2800/I	This calibration Certificate may be reproduced other than in full except the permission of the NABL and the issuing laboratory.
Serial number	11283-98	Calibration Certificate without signatures and seal are not valid.
Customer	Internal Calibration WIKI INDIA CALIBRATION LABORATORY	The results in this certificate only relate to the object stated. Recommended Cal.Frequency for object-5 Years
Order No.	Internal	
Number of pages of the certificate	8 pages + enclosure	
Date of calibration	11-Mar-14	

This calibration certificate may not be reproduced other than in full except with the permission of both the Accreditation Body of the NABL and the issuing laboratory. Calibration certificates without signature and seal are not valid.



Seal

Date

11/ March 2014

Calibrated by

V.Patil

For Head of Cal. Laboratory

Kshirsagar

Pressure + Temperature



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Object (DUT)**Deadweight-tester**

Serial- No.

11283-98

Pressure range

0.20bar...1100bar

Accuracy according to the manufacturer

0.015 %

Number of piston- cylinder systems

2

Pressure range from [bar]	10	0.2	
Pressure range until [bar]	1000	55	
Piston - cylindersystem	L519	L360	
Material piston	Steel	Steel	
Material cylinder	Steel	Steel	

Weight - set

-Serial - No.:

11283-98

-Number of weights:

20

-Material of the weights:

SS

Stroke of the piston

15

Pressure reference level

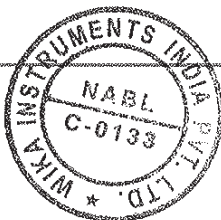
Horizontal level which pass through the level of the lower edge of the piston in measuring position.

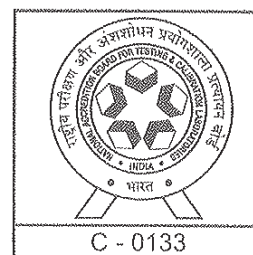
Float position of piston

The measuring position of the piston is at the half stroke.

Pressure + Temperature

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Reference

Name

Model-CPB5000, Range- 0.2/1000 bar, Validity- 13/09/16

CalibrationNo.

A4553, Accuracy-0.008% rdg, serial number-2116 & 3136

Calibration conditions

Pressure media for calibration	ST25	with $p_{20^{\circ}\text{C}}$ =	870.00
Temperature of the piston- cylinder system in $^{\circ}\text{C}$	22.66		+/- 0.05

Ambient conditions

Place	Laboratory
local gravity in m/s^2	9.783667

Mass determination

Room temperature in $^{\circ}\text{C}$	22.70	+/- 1
Ambient pressure in mbar	944.30	+/- 1

Area determination

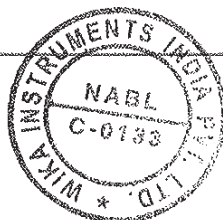
Room temperature in $^{\circ}\text{C}$	22.30	+/- 1
Ambient pressure in mbar	944.40	+/- 1

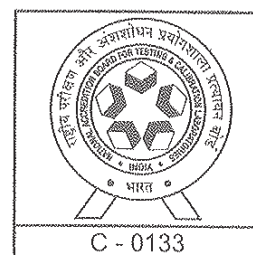
Calibration process

For the calibration are used the following norms:

- Guideline EA-4/17 "Calibration of pressure balance", July 1997
- Guideline EAL-R2 "Expression of the uncertainty of measurement in calibration", December 1999

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Results

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For the effective area A_0 at overpressure $p_o=0$ and at the temperature 20°C following values for the temperature coefficients ($\alpha+\beta$) and for the distortion coefficient λ of the piston-cylinder-systems are detected:

Pressure range from [bar]	10	0.2	
Pressure range until [bar]	1000	55	
Piston - cylindersystem	L519	L360	
Effective area A_0 in m^2	$4.033237\text{E}-06 \pm 1.553737\text{E}-10$	$8.069638\text{E}-05 \pm 2.665848\text{E}-09$	
TC ($\alpha + \beta$) in K^{-1}	$2.2\text{E}-05 \pm 1\text{E}-06$	$2.2\text{E}-05 \pm 1\text{E}-06$	
Distortion coefficient λ in Pa^{-1}	$3.974361\text{E}-12 \pm 5.961542\text{E}-13$	$0.000\text{E}+00 \pm 0.000\text{E}+00$	

Following values are measured about the measuring system:

Measuring system	Pressure [bar]	Sinkrate [mm/min]	Pressure [bar]	Free rotation time [min]
L519	1000	1	200	5
L360	55	1	11	5

All values are valid, if the piston is floating and rotating in measurement position.

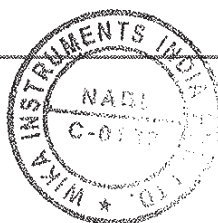
The reported uncertainty values for the effective area and for the mass values accord to the expanded uncertainty, which is the standard uncertainty multiplied with the coverage factor $k=2$.

The uncertainty is determined according to EA 10/03.

The values are in this range with a coverage probability of 95%.

These values do not cover the long-term stability.

Pressure + Temperature



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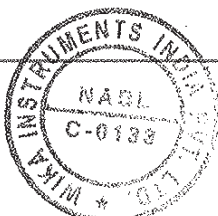
True mass of the weights:

[illegible]

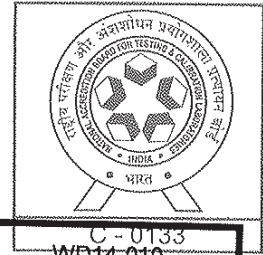
*1) Consideration of hollow volume, boost volume and surface tension

Pressure + Temperature

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C - 0133
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Calculation of the values for a deadweight-tester

The measured overpressures with the deadweight-tester at the reference level can be calculated in the unit bar with the following numerical equation. The overpressure is with the using of the already defined symbols and the values in the denoted unit:

$$p_e = g_n \cdot \frac{\sum m_i \cdot (1 - \frac{p_L}{\rho})}{A(p_e, t)} \cdot 10^{-5}$$

Thereby is g_n the local gravity in m/s^2 .

$\sum m_i(1 - p_L/\rho)$ is the total mass of piston, bell and all masses corrected by air-bouancy.

$A(p_e, t)$ is the effective area at the overpressure p_e in bar and at a divergent measuring temperature to $20^\circ C$:

$$A(p_e, t) = A_0 [1 + (\alpha + \beta) \cdot (t - 20^\circ C) + \lambda p_e]$$

Middle values of overpressure can be displayed by adding trim masses with known density.

The overpressure p_e can also be calculated by the sum of the overpressure (see table) for the used piston, bell and all masses multiplied with the factor

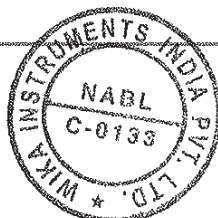
$$\frac{g}{g_n} \cdot \frac{1}{1 + (\alpha + \beta) \cdot (t - 20) + \lambda \cdot p_e}$$

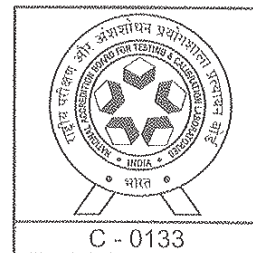
Thereby is t the measuring-temperature in $^\circ C$ at the piston-cylindersystem.

For the reference level of the DUT the pressure difference to the piston-lower-edge must be considered, if needed.

For detailed information: enclosure 2

Pressure + Temperature





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Expanded uncertainty

Denoted is the expanded uncertainty, which is calculated out of the standard uncertainty by multiplying with the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of 95%. The values are calculated according to **DKD- 3**.

Piston L519

Uncertainty
At least:

0.01
4

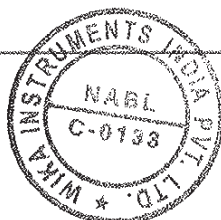
% of reading
mbar

Piston L360

Uncertainty
At least:

0.01 % of reading
0.40000001 mbar

Pressure + Temperature





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Label

The basement of the deadweight-tester is labeled with a calibration mark, which shows the NABL-sign.

All masses are additionally labeled with their own, consecutively numbers.

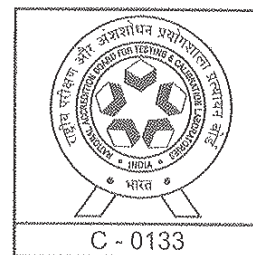
More helpinformation for the effective application of a deadweight-tester

In the enclosure 1 choosen pressure values are calculated .
(valid for $t=20^{\circ}\text{C}$ and for the local gravity)

Enclosure 2 shows the corrections
for using the dead-weight tester not under reference- conditions.

Pressure + Temperature





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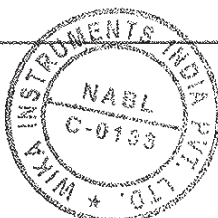
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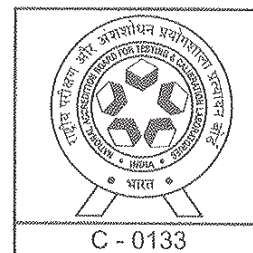
Pressure values of the masses under reference conditions:

[illegible]

Pressure + Temperature

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Notes for the application of a deadweight-tester

If the conditions like in the calibration certificate cannot be kept, then the pressure values must be corrected.

Deviation from the reference level

Is there a significant height difference between the reference level of the reference and the device under test, a pressure correction must be calculated due to the additional static pressure.

$$p_h = -g \cdot (\rho_m - \rho_l) \cdot (h' - h)$$

Thereby are:

p_h Correction due to height differences
 g Gravity
 ρ_m Density of the media, for gases apply

$$\rho(p, t) = \rho(p_0, t_0) \cdot \frac{p_{abs} \cdot 297,15K}{1bar \cdot (273,15 + t)}$$

Thereby are:

$\rho(p_0, t_0)$ the density of the gas under standard conditions

($p_0=1013$ mbar, $t_0=0^\circ C$)

for nitrogen: 1,255 kg / m³

for air: 1,293 kg / m³

t the temperature of the gas

p_{abs} the absolute pressure of the gas

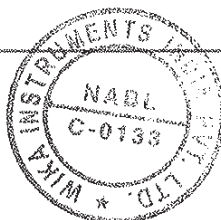
ρ_l air density

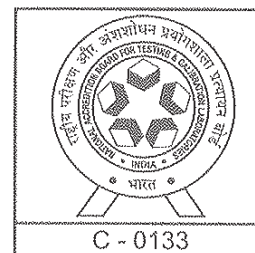
($h' - h$) Height difference between the reference level of the reference and the device under test

Attention:

The hydrostatic pressure will be added to the reference pressure, if the reference level of the reference is higher than the device under test. The pressure will be subtract, if the reference level is lower than the reference's.

Pressure + Temperature





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Notes for the application of a deadweight-tester

If the conditions like in the certificate cannot be kept, then the pressure values must be corrected.

Deviation from the reference temperature 20°C

If the pressure should be calculated for a temperature different 20°C, a correction factor must be added to the overpressure of the loaded masses.

$$p_{\delta} = -(\alpha + \beta) \cdot (t - t_{20}) \cdot p_{20}$$

Thereby are:

p_{δ}	Correction due to temperature differences
$\alpha + \beta$	Temperature coefficient of the piston-cylinder system
t	Temperature of the measuring system
t_{20}	Reference temperature 20°C
p_{20}	Pressure value according to the certificate

Pressure + Temperature

