

# Model CPB3800 Portable Deadweight Tester



Data Sheet CPB3800 • 12/2012

## Applications

- Primary standard for ranges up to 16,000 psi hydraulic
- Reference instrument for factory and calibration laboratories for the testing, adjustment and calibration of pressure measuring instruments
- Complete, stand-alone system, suitable for field use

## Features

- Total measurement uncertainty to 0.025 % of measured value
- Factory calibration includes NIST traceable certificate
- High long-term stability with recommended recalibration cycle every five years
- Masses manufactured from stainless steel and can be adjusted to local gravity
- Compact dimensions for portable use



Model CPB3800 Deadweight Tester

## Description

### Proven primary standard

Deadweight testers are the most accurate instruments available used to calibrate electronic or mechanical pressure measuring instruments. They measure pressure directly, relying on primary physical properties.

$$p = F/A$$

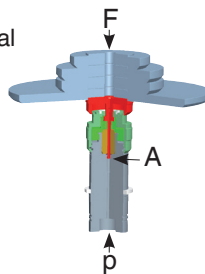
Where:

$p$  = Pressure;  $F$  = Force;  $A$  = Area

In a deadweight tester the force,  
 $F$  = Mass x the acceleration of gravity.

This well known physical relationship combined with the use of high-quality materials, produces small measurement uncertainties and a long-term stability of five years.

Deadweight testers have been used for years in factory and calibration laboratories in industry, national institutes and research laboratories. Historically, they have been the primary standard for pressure calibration and measurement.



### Stand-alone operation

Due to its integrated pressure generation and fundamental mechanical measuring principles requiring no electrical power, the model CPB3800 is ideal for field use in the maintenance and service of remote pressure instruments.

### Basic principle

The core component of the CPB3800 is a precisely manufactured piston-cylinder system which is loaded with masses in order to generate individual pressure test points. Precise measurement of test conditions plus the quality built into the CPB3800 provide percent of reading uncertainties to 0.025%

The masses applied are proportional to the target pressure; this is achieved by adding optimally graduated masses. Masses are manufactured to the standard gravity (9.80665 m/s<sup>2</sup>), though they can be adjusted to a specific location gravity and calibrated to NIST Standards.

## Operation

The integrated dual-area pump enables rapid filling of the test system and smooth pressure generation up to 16,000 psi. At the same time, the precise adjustable spindle pump also serves for fine adjustment. A control schematic for pressure generation on the instrument base facilitates quick and easy operation.

As soon as the measuring system reaches equilibrium, there is a balance of forces between the pressure and the mass load applied. The quality of the system and precise tolerances allow this equilibrium to persist over time so that the pressure remains stable. The pressure value is read and compared to a device under test (DUT). Adjustments can be carried out on the DUT during this sustained generation of pressure.

## Compact instrument design

The CPB3800 is also particularly notable for its compact dimensions which are not altered during operation due to the spindle that runs within the pump body.

With its compact dimensions, robust ABS plastic housing and the low weight associated with these, the CPB3800 is also particularly suited to on-site applications.

## The piston-cylinder system

The piston and cylinder are manufactured from tungsten carbide. These materials provides low coefficients of expansion due to temperature and pressure which results in a excellent linearity for the cross-sectional area and a very high accuracy.

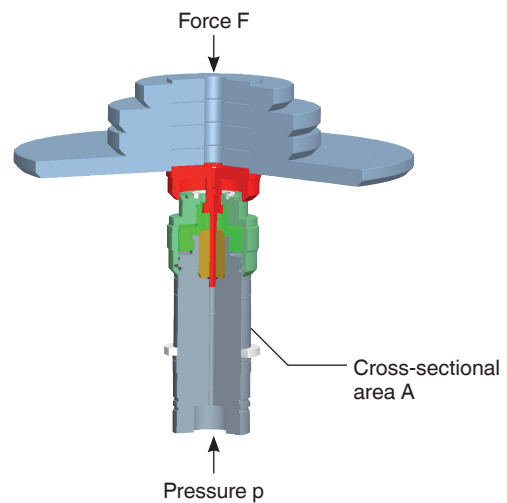
The piston and cylinder are protected from contamination and mechanical damage within a solid stainless-steel housing. Overpressure protection is incorporated into this housing and prevents the piston from being forced out vertically and damaged if masses are inadvertently removed from the system while under pressure.

The masses are stacked on an overhang (bell) which sits on the piston shaft. The construction of the overhang provides a low center of gravity for the stacked weights, which minimizes side thrust and friction on the piston-cylinder system. For lower pressures, the masses can also be stacked directly on the piston shaft, without using the overhang.

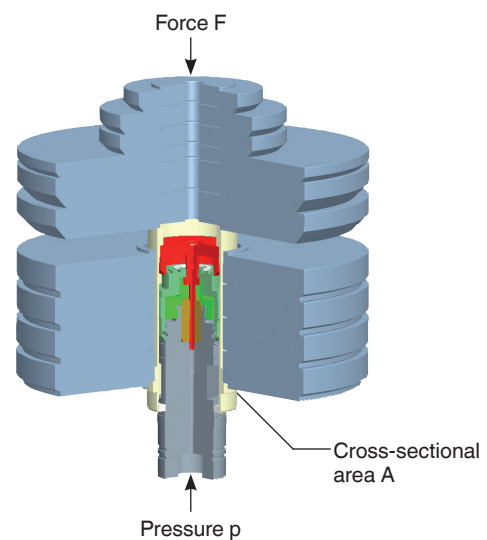
The overall design of the piston-cylinder unit and the precision in the manufacturing of both the piston and the cylinder, ensures excellent operating characteristics with long free-rotation time and low sink rates. These characteristics insure long-term stability and allow for a recommended recalibration interval of five years depending on the conditions of usage.



Control schematic on the CPB3800 instrument base



Piston-cylinder system with masses, without overhang (bell)



Piston-cylinder system with masses, with overhang (bell)

## Tables of masses

The following tables show, for the respective measuring range, the number of masses within a set of masses, and their resulting nominal pressures.

The masses are manufactured, to the standard gravity (9.80665 m/s<sup>2</sup>) although they can be adjusted for any particular location.

When operating outside of standard reference conditions (ambient temperature 20 °C, air pressure 29.9 in. Hg A, relative humidity 40 %), the relevant corrections must be made.

Measuring range [lb/in <sup>2</sup> ]	10 ... 1,600		25 ... 4,000		50 ... 10,000		100 ... 16,000	
	Quantity	Nominal pressure per piece [lb/in <sup>2</sup> ]	Quantity	Nominal pressure per piece [lb/in <sup>2</sup> ]	Quantity	Nominal pressure per piece [lb/in <sup>2</sup> ]	Quantity	Nominal pressure per piece [lb/in <sup>2</sup> ]
Piston	1	10	1	25	1	50	1	100
Overhang (bell) and overhang make-up weight	1	190	1	475	1	950	1	1,900
Masses (stackable on overhang (bell))	5	200	5	500	7	1,000	5	2,000
Masses (stackable on piston)	1	200	1	500	1	1,000	1	2,000
	1	100	1	250	1	500	1	1,000
	2	40	2	100	2	200	2	400
	1	20	1	50	1	100	1	200
	1	10	1	25	1	50	1	100

Measuring range [bar]	1 ... 120		2.5 ... 300		5 ... 700		10 ... 1,200	
	Quantity	Nominal pressure per piece [bar]	Quantity	Nominal pressure per piece [bar]	Quantity	Nominal pressure per piece [bar]	Quantity	Nominal pressure per piece [bar]
Piston and make-up weight	1	1	1	2.5	1	5	1	10
Piston, overhang (bell) and overhang make-up weight	1	20	1	50	1	100	1	200
Masses (stackable on overhang (bell))	3	20	3	50	4	100	3	200
Masses (stackable on piston)	1	20	1	50	1	100	1	200
	1	10	1	25	1	50	1	100
	2	4	2	10	2	20	2	40
	1	2	1	5	1	10	1	20
	1	1	1	2.5	1	5	1	10

## Scope of delivery

- Base
- Dual-area pump for filling, pressure generation and fine adjustment
- Piston connection with G ¾ B male thread
- Test item connection with G ½ female thread, free-running
- NPT adapter set for G ½ B male test item connector to ¼ NPT, ¼ NPT, ⅜ NPT and ½ NPT female
- Piston-cylinder system with overhang (bell)
- Set of masses manufactured to standard gravity (9.80665 m/s<sup>2</sup>)
- VG22 mineral oil (0.5 litre)

- Tool and maintenance set
  - Two 30 mm wrenches
  - Set of sealing o-rings
- Operating instructions
- NIST traceable calibration certificate

## Options

- System with increased accuracy to 0.025 %
- Set of masses manufactured to local gravity
- Storage case for the base, mass set and the piston-cylinder system

# Specifications

## Model CPB3800

### Piston-cylinder systems

<b>Measuring range <sup>1)</sup></b>	lb/in <sup>2</sup>	10 ... 1,600	25 ... 4,000	50 ... 10,000	100 ... 16,000
Required masses	kg	38	47	58	47
Smallest step <sup>2)</sup> (Standard mass set)	lb/in <sup>2</sup>	10	25	50	100
Nominal cross-sectional area of the piston	cm <sup>2</sup>	0.4032	0.1613	0.0807	0.0403
<b>Measuring range <sup>1)</sup></b>	bar	1 ... 120	2.5 ... 300	5 ... 700	10 ... 1,200
Required masses	kg	41	50	58	50
Smallest step <sup>2)</sup> (Standard mass set)	bar	1	2.5	5	10
Nominal cross-sectional area of the piston	cm <sup>2</sup>	0.4032	0.1613	0.0807	0.0403

#### Accuracies

Standard <sup>3) 4)</sup>	% of measured value	0.05
Option <sup>3) 4)</sup>	% of measured value	0.025

#### Pressure transmission medium

Hydraulic fluid based on VG22 mineral oil (0.5 l included in scope of delivery)

#### Material

Piston		Tungsten carbide
Cylinder		Tungsten carbide
Mass set		Stainless steel, non-magnetic

#### Weight

Piston-cylinder system	kg	2.4			
BAR set of masses incl. overhang (bell)	kg	41.5	50.5	58.5	50.5
lb/in <sup>2</sup> set of masses incl. overhang (bell)	kg	38.5	47.5	58.5	47.5
Carrying case for set of masses (optional, 2 pieces required)	kg	5.8			

#### Dimensions

Carrying case for set of masses (optional)		15.75 x 12.2 x 12.2 in. (400 x 310 x 310 mm) (W x H x D)
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- 1) Theoretical starting value; corresponds to the pressure value generated by the piston or the piston and its make-up weights (by their own weight). To optimize the operating characteristics more weights should be loaded.
- 2) The smallest pressure change value that can be achieved based on the standard weight set. To reduce this, a set of trim masses is also available.
- 3) The accuracy from 10 % to 100% of the measuring range is based on the measured value. In the lower range, a fixed error based on 10 % of the range applies.
- 4) Measurement uncertainty assuming reference conditions (ambient temperature 20 °C, air pressure 29.9 in. Hg A, relative humidity 40 %). Corrections must be made if required, or use the optional CPU5000 to automatically make corrections

## Base

### Connections

Connection for piston-cylinder system	G ¾ B (male)
Test item connection	G ½ female thread, free-running, incl. adapter set to ⅛ NPT, ¼ NPT, ⅜ NPT and ½ NPT female

### Material

Tubing in instrument base	Stainless steel 6 x 1.5 mm
<b>Pressure transmission medium</b>	Hydraulic fluid based on VG22 mineral oil (0.5 Liter, included in scope of delivery)
Reservoir	170 cm <sup>3</sup>

### Weight

Base	36 lbs. (13.5 kg)
Storage case for the base (optional)	22.8 lbs. (8.5 kg)

### Permissible ambient conditions

Operating temperature	64 ... 83°F (18 ... 28 °C)
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### Dimensions

Base	15.8 x 15.6 x 10.2 in. (401 x 397 x 259 mm) (W x D x H), for details, see technical drawings
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## Approvals and certificates

### CE conformity

Pressure equipment directive	97/23/EC (Module A)
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### Certificate

Calibration	NIST Traceable Calibration Certificate
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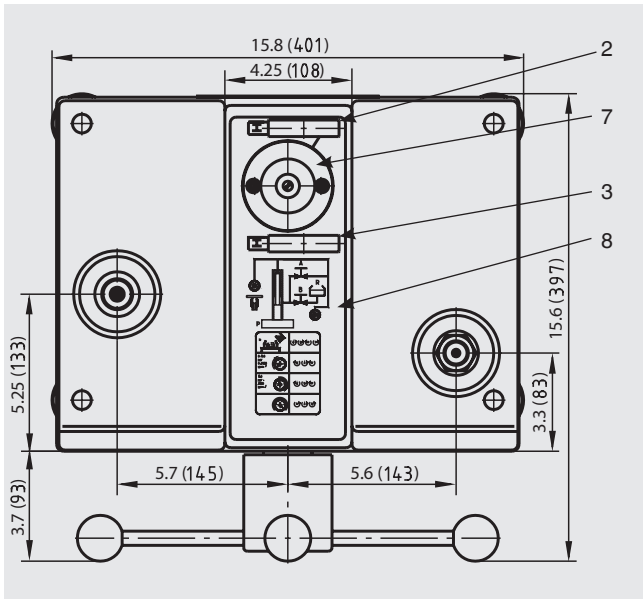
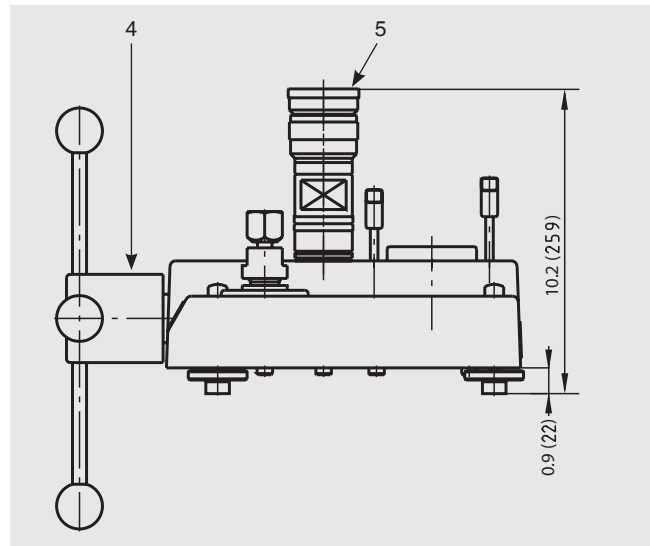
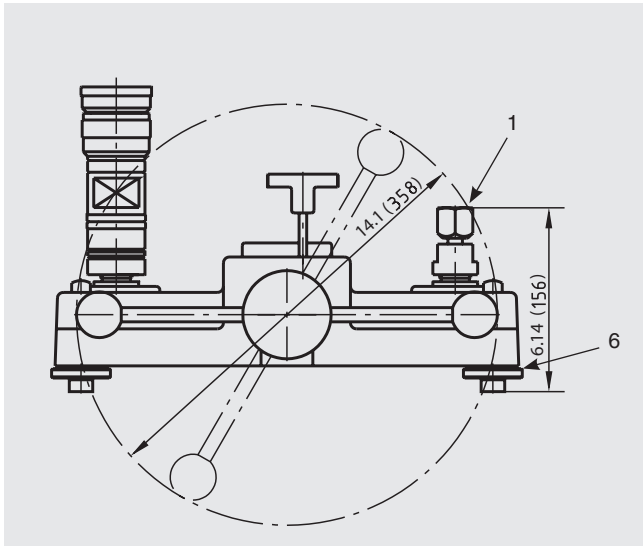
## Transport dimensions for complete instrument

The complete instrument, in its standard version and standard scope of delivery, consists of three packages with the following dimensions and weights, dependent upon measuring range.

Version	Box 1 with base, piston-cylinder system, standard accessories Dimensions: 590 x 490 x 380 mm		Boxes 2 and 3 with set of masses Dimensions: 320 x 320 x 280 mm	
	Weight in lbs. (kg)		Weight in lbs (kg) per box	
	net	gross	net	gross
1 ... 120 bar	37.5 (17)	44 (20)	91.5 (41.5)	100 (45)
2.5 ... 300 bar	41 (18.5)	47.4 (21.5)	112 (50.5)	119 (54)
5 ... 700 bar	41 (18.5)	47.4 (21.5)	129 (58.5)	138 (62.5)
10 ... 1,200 bar	41 (18.5)	47.4 (21.5)	112 (50.5)	119 (54)
10 ... 1,600 lb/in <sup>2</sup>	37.5 (17)	44 (20)	85 (38.5)	92.5 (42)
25 ... 4,000 lb/in <sup>2</sup>	41 (18.5)	47.4 (21.5)	105 (47.5)	112 (51)
50 ... 10,000 lb/in <sup>2</sup>	41 (18.5)	47.4 (21.5)	129 (58.5)	138 (62.5)
100 ... 16,000 lb/in <sup>2</sup>	41 (18.5)	47.4 (21.5)	105 (47.5)	112.5 (51)

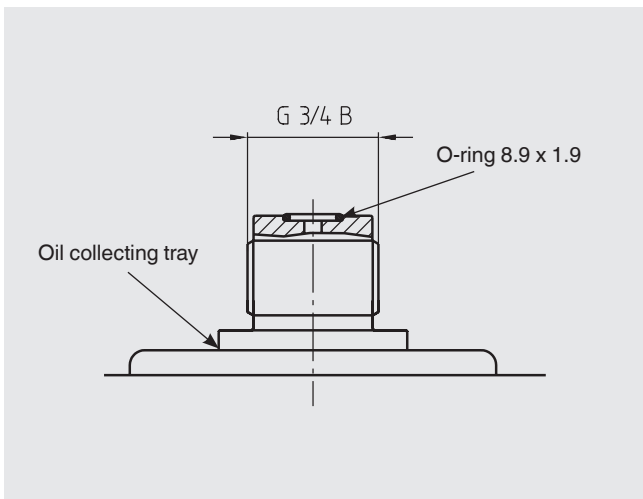
## Dimensions: inches (millimeter)

(without masses)

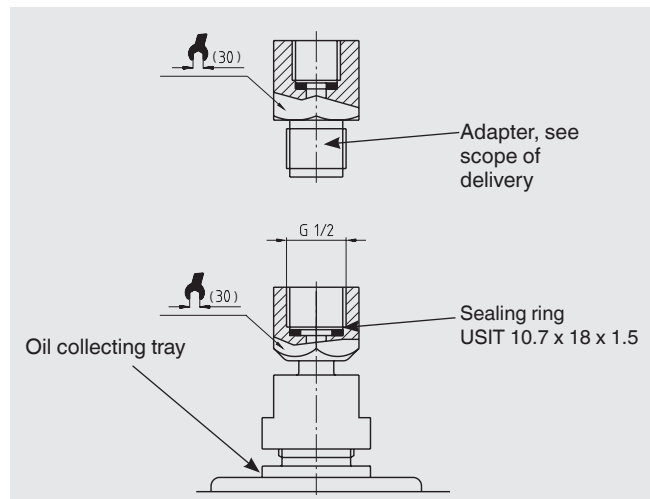


- (1) Test connection
- (2) High-pressure shut-off valve
- (3) Low-pressure shut-off valve
- (4) Dual-area pump with star handle
- (5) Piston-cylinder system
- (6) Adjustable feet
- (7) Reservoir with sealing plug
- (8) Pressure generation control schematic

### Standard connection piston-cylinder system



### Test item connection



## Deadweight testers in our calibration technology program

### Model CPB5800 Deadweight tester

#### Measuring ranges:

- Hydraulic      Single-piston measuring ranges:  
10 ... 1,600 up to 30 ... 4,000 psi  
or  
1 ... 120 up to 2 ... 300 bar
- Dual-piston measuring ranges:  
10 ... 800 / 100 ... 10,000 psi up to  
10 ... 800 / 200 ... 20,000 psi  
or  
1 ... 60 / 10 ... 700 bar up to  
1 ... 60 / 20 ... 1,400 bar

**Accuracy:**            0.015 % of measured value  
                             up to 0.006 % of measured value (optional)



Model CPB5800 Deadweight tester

### Model CPB5000HP Deadweight tester for high pressure

#### Measuring ranges:

- Hydraulic      350 ... 40,000, 350 ... 60,000,  
350 ... 70,000 psi  
-or-  
25 ... 2,500, 25 ... 4,000 or 25 ... 5,000 bar
- 600 / 40,000 psi dual piston  
-or-  
50 / 2,600 bar dual piston

**Accuracy:**            0.025 % of measured value  
                             0.02 % of measured value (optional)



Model CPB5000HP Deadweight tester for high pressure

### Model CPB5000DP Deadweight tester for differential pressure

#### Measuring range = (static pressure + differential pressure):

- Pneumatic     0.435 ... 30 up to 5.8 ... 1,500 psi  
-or-  
0.03 ... 2 up to 0.4 ... 100 bar
- Hydraulic      2.9 ... 1,000 up to 29 ... 14,500 psi  
-or-  
0.2 ... 60 up to 2 ... 1,000 bar

**Accuracy:**            0.015 % of measured value  
                             0.008 % of measured value (optional)

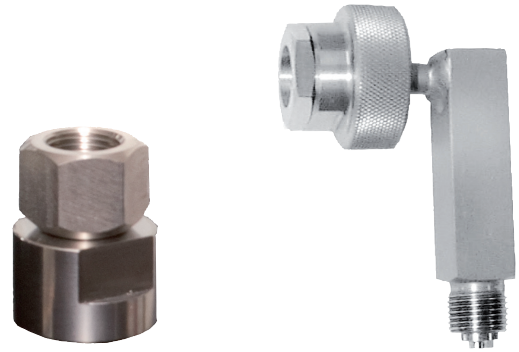


Model CPB5000DP Deadweight tester for differential pressure

## Accessories

### Test connections

With the existing standard test item connection, test items with radial connection points can be mounted. For units with rear connection points, a 90° angle connector is available, with ¼ to ½ female NPT adaptors, which can be mounted in place of the piston-cylinder system on the piston connector, the CPB3800 instrument base can be used as a comparison test pump.



**Fig. left: Gauge adapter, G ¼ female to G ½ female**  
**Fig. right: Angle connector 90°**

### Separators

The separators (with diaphragm) have been specifically designed for measuring instruments, which should not come into contact with the medium of the deadweight tester or to protect against contamination of the deadweight tester from the test items.



**Fig. left: Separator (with diaphragm) 10,000 psi**  
**Fig. right: Separator (with diaphragm) 16,000 psi**

Accessories	Order no.
CPU5000 Calibrator Unit (automatically makes corrections for environmental conditions)	CPU5000
Set of trim masses (1 mg up to 50 g), class F1	7093874
Set of trim masses (1 mg up to 50 g), class M1	14025325
Set of 2 carrying cases for set of masses	14031236
Storage case for CPB3800 instrument base	14031237
"BSP" adapter set for G ½ B male test item connector to G ⅛, G ¼, G ⅜ and G ½ female	14031238
"Metric" adapter set for G ½ B male test item connector to M12 x 1.5 and M20 x 1.5 female	14031242
Test item connection, G ¼ female to G ½ female, free-running	14031251
90° angle connection, for test items with back mounting connection	1564838
Separator (to separate two liquid media by a diaphragm), max. 10,000 psi	14031253
Separator (to separate two liquid media by a diaphragm), max. 16,000 psi	14031254
Sealing set for CPB3800 instrument base	14031255
Operating fluid for CPB series up to a max. 4,000 bar, 0.5 litre	2099954
Tool set consists of open-ended wrench, BSP adapter, replacement seals, pointer removal device and pointer press-on tool	14031263



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