

P3000 Deadweight Tester Setup, Part 1: Limited Partial Correction Method

19 May 2014

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This tutorial is for configuring a P3000 series (Pressurements) deadweight tester to be used with COMPASS for Pressure software in the *Limited Partial Correction* method. A second tutorial addresses configuring the software for *Full* or *Partial Correction* methods of operation.

In short, the *Limited Partial Correction* method uses COMPASS for Pressure to make a local gravity correction. This is the simplest approach for using software with a deadweight tester.

The user should be familiar with the P3000 Series Uncertainty Analysis technical note 2170TN13 -- "Guide for the Uncertainty Analysis in Pressure when using P3000 Series Deadweight Testers".

<http://us.flukecal.com/literature/articles-and-education/pressure-calibration/application-notes/guide-uncertainty-analysis->

The technical note defines several methods of operating a deadweight tester as a means to attain various levels of performance. The following three methods are described in 2170TN13: *Full Correction*, *Partial Correction*, and *No Correction*. Due to the structure of the COMPASS for Pressure Piston Gauge Calculator tool, a fourth term is introduced in this tutorial -- "*Limited Partial Correction*".

Full Correction:

- The pressure is calculated for the influences of ambient conditions, piston-cylinder temperature, fluid head, and changes to the effective area of the piston due to deformation. This method is nearly identical to calculations required for a piston gauge.
- The P3000 device definitions are configured as a "Piston Gauge".
- This method is addressed in technical note 2170TN13.

Partial Correction:

- Corrections to the nominal pressure are limited to the temperature of the piston-cylinder, acceleration of local gravity, and DUT fluid head.
- The P3000 device definitions are configured as a "Piston Gauge"
- From an operations perspective with COMPASS for Pressure, there is not much difference between this and the *Full Correction* method other than not needing to update the ambient conditions.
- This method is addressed in technical note 2170TN13.

NOTE: Per technical note 2170TN13, the term *Partial Correction* is defined as correcting for local gravity and piston-cylinder temperature. In COMPASS, when the Platform Type selection is “Deadweight Tester”, a correction for piston-cylinder temperature is not included. COMPASS limits the correction to local gravity (and fluid head) only. This is why the term *Limited Partial Correction* is used.

Limited Partial Correction:

- Only local gravity and a fluid head correction are applied.
- The P3000 device definitions are configured as a “Deadweight Tester”.
- This term is not used in technical note 2170TN13.

No Correction:

- This method is referred to as “stack-and-spin” and does not require software. The nominal pressure values of the weights are summed together and represent the reference pressure.
- This method is addressed in technical note 2170TN13.

The required tasks for this setup include:

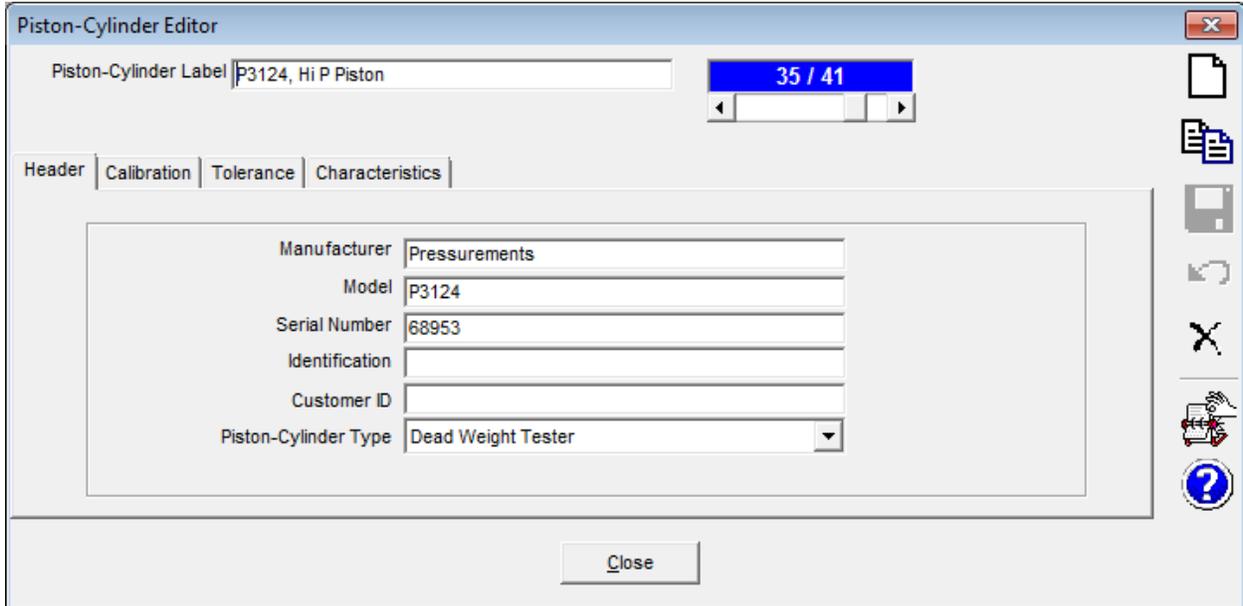
- ✓ Create the Piston-Cylinder definition
- ✓ Create the Weight Set definition
- ✓ Create the Deadweight Tester definition
- ✓ Configuring local gravity

The screen shots are specific to a P3124, but are applicable to the P3000 Series models and the principles can be extended to other 3rd Party DWTs.

Creating the Piston-Cylinder definition: [Setup],<Piston Gauge> → "Piston-Cylinder"

The critical selection is the "Piston-Cylinder Type". The choice of Dead Weight Tester fundamentally changes how COMPASS handles the metrology. With the choice of Dead Weight Tester, the reference pressure is calculated as simply the sum of the pressure values assigned to the weights.

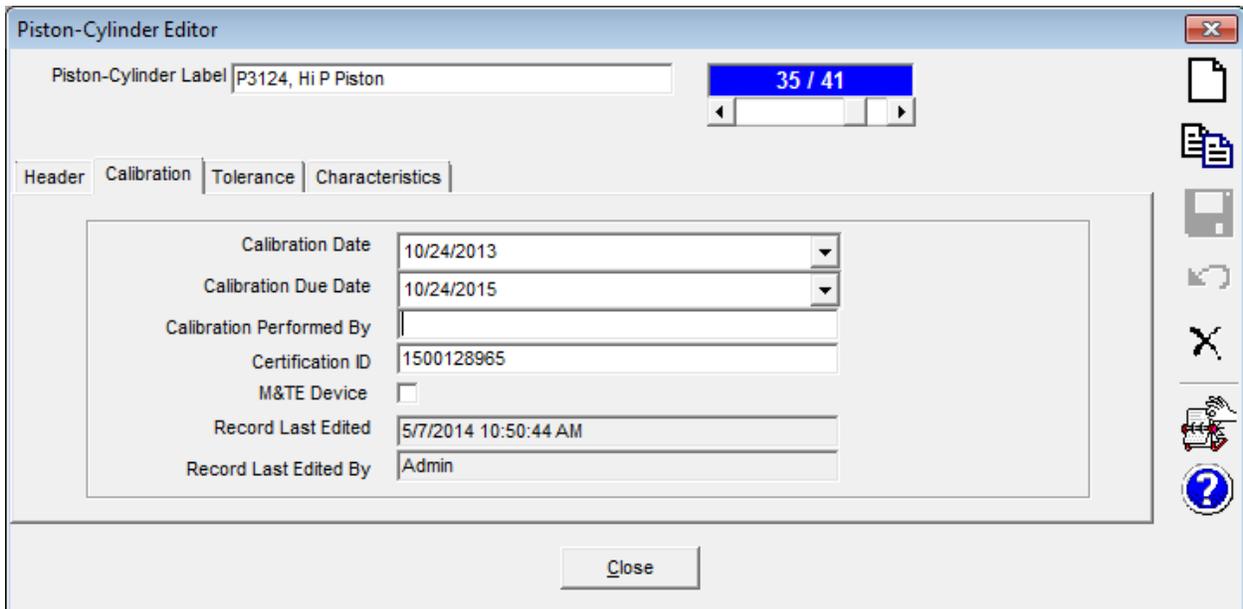
At a minimum only a serial number, Identification, or Customer ID is required for a valid setup.



The screenshot shows the "Piston-Cylinder Editor" window with the "Characteristics" tab selected. The "Piston-Cylinder Label" is "P3124, Hi P Piston". The "Piston-Cylinder Type" is set to "Dead Weight Tester".

Manufacturer	Pressurements
Model	P3124
Serial Number	68953
Identification	
Customer ID	
Piston-Cylinder Type	Dead Weight Tester

The calibration tab fields are optional, and are not required for a valid setup.

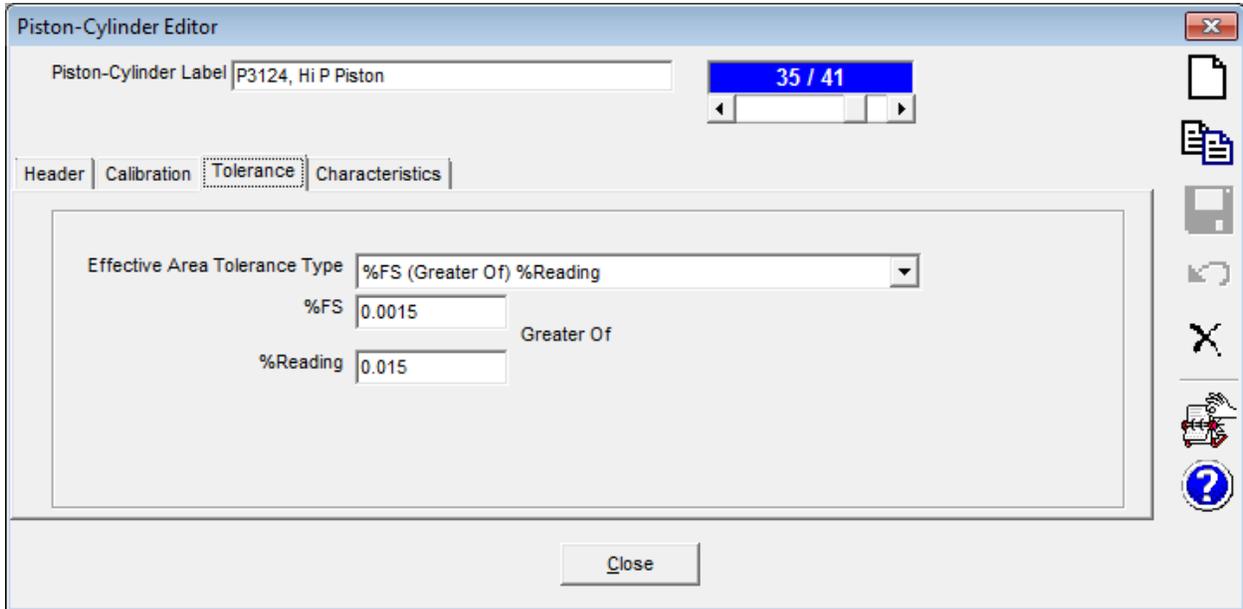


The screenshot shows the "Piston-Cylinder Editor" window with the "Calibration" tab selected. The "Piston-Cylinder Label" is "P3124, Hi P Piston".

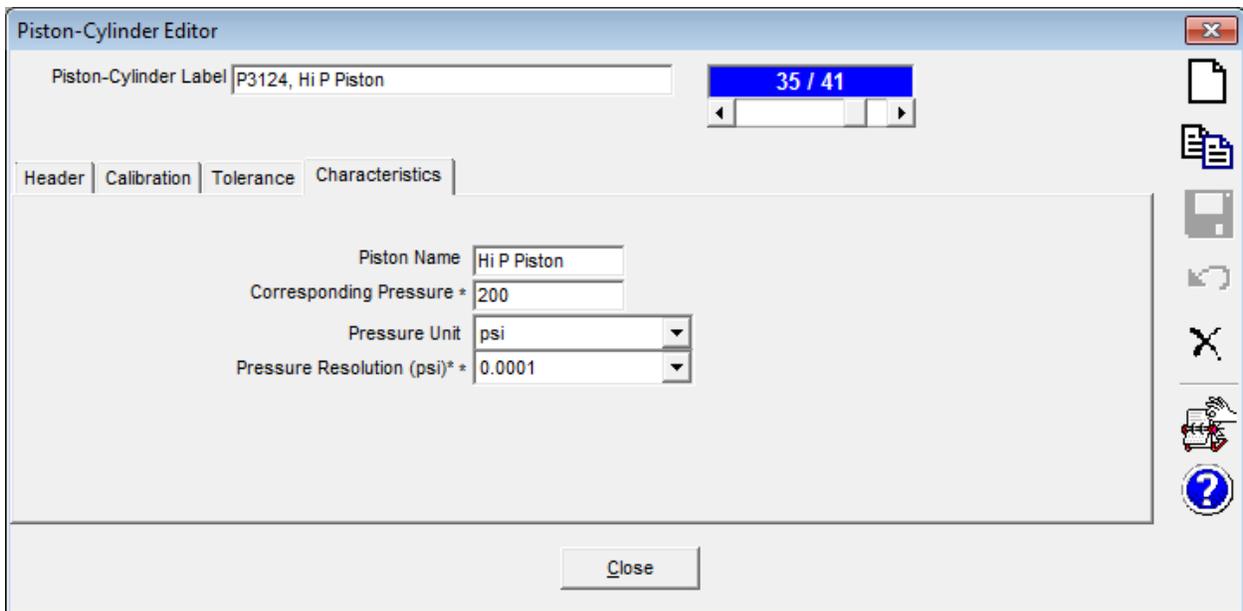
Calibration Date	10/24/2013
Calibration Due Date	10/24/2015
Calibration Performed By	
Certification ID	1500128965
M&TE Device	<input type="checkbox"/>
Record Last Edited	5/7/2014 10:50:44 AM
Record Last Edited By	Admin

The tolerance specification reflects the standard uncertainty that can be attained when software is not used for the secondary corrections. This assumes the DWT is being used in the location for which it was

manufactured, or if a local gravity correction is applied.



The Characteristics tab associates a pressure value with the piston-cylinder. In this situation the weight of the Hi P Piston is a combination of the weight of the piston + weight carrier tube + tare weight. It is intended that the weight carrier tube and tare weight will always be used with the piston and therefore the minimum pressure is defined as 200 psi.



Creating the Weight Set: [Setup],<Piston Gauge> → "Mass Set"

The critical selection is the "Mass Set Type". The choice of Dead Weight Tester fundamentally changes how COMPASS handles the metrology. With the choice of Dead Weight Tester, the reference pressure is calculated as the sum of the pressure values assigned to the weights. The mass of the weights is not required for use with COMPASS.

At a minimum only a serial number, Identification, or Customer ID is required for a valid setup.

The screenshot shows the 'Mass Set Editor' window with the 'Mass Set' tab selected. The 'Mass Set Label' is 'P3124 Weight Set'. The '21 / 27' indicator is visible. The 'Header' tab is also visible. The main form contains the following fields:

Manufacturer	Pressurements
Model	P3124
Serial Number	68953
Identification	
Customer ID	
Mass Set Type	Dead Weight Tester

A 'Close' button is located at the bottom center of the window.

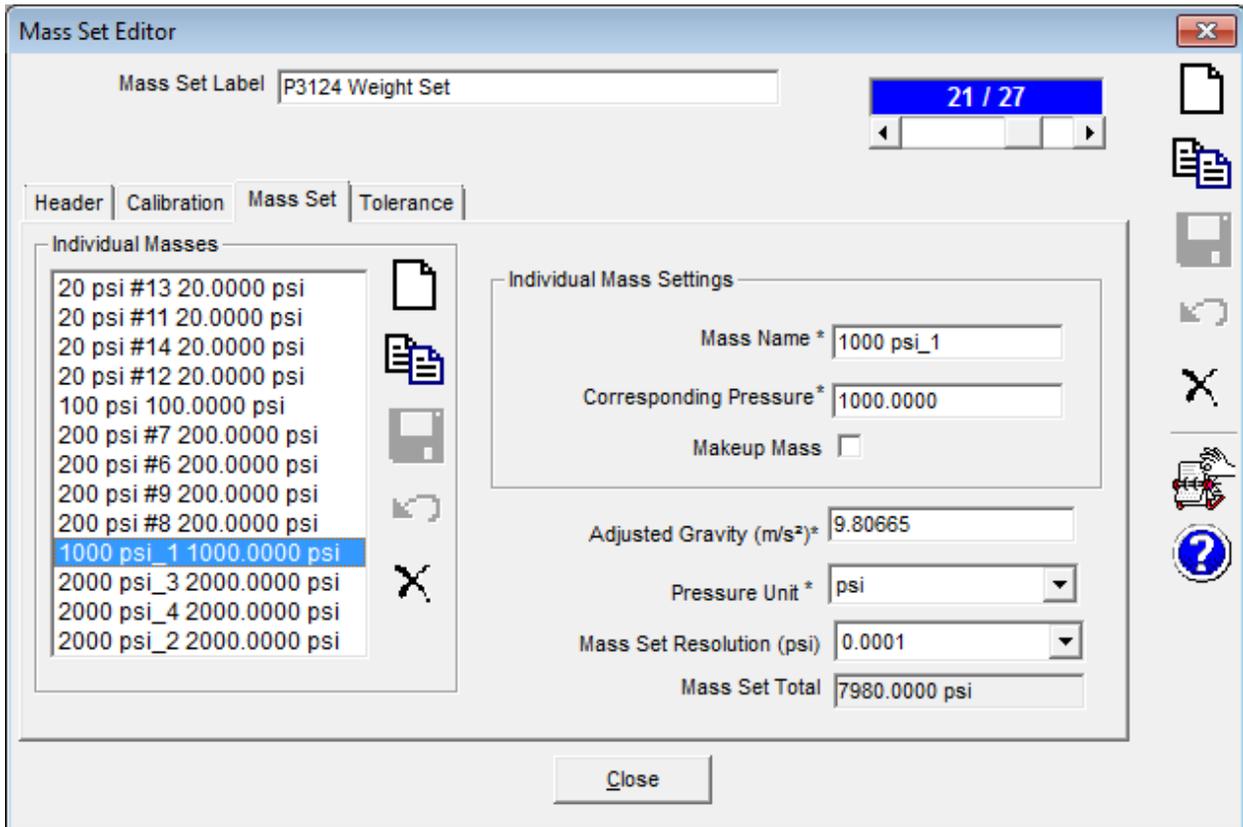
The fields in the calibration tab are optional, and are not required for a valid setup.

The screenshot shows the 'Mass Set Editor' window with the 'Calibration' tab selected. The 'Mass Set Label' is 'P3124 Weight Set'. The '21 / 27' indicator is visible. The 'Header' tab is also visible. The main form contains the following fields:

Calibration Date	10/24/2013
Calibration Due Date	10/24/2013
Calibration Performed By	
Certification ID	1500128965
M&TE Device	<input type="checkbox"/>
Record Last Edited	5/8/2014 9:24:17 AM
Record Last Edited By	Admin

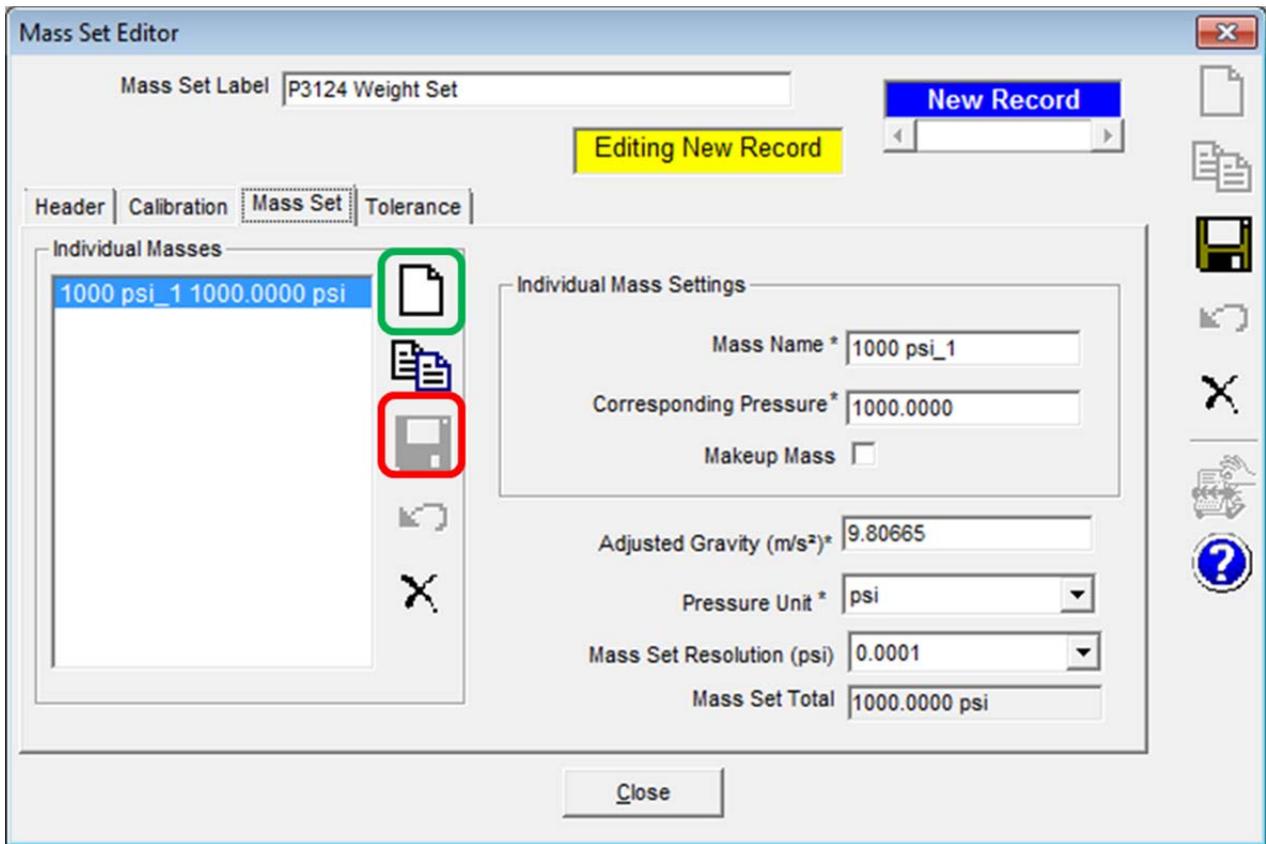
A 'Close' button is located at the bottom center of the window.

The Mass Set tab is a summary of the individual weights and the associated pressure. The screen shot shows a completed weight set.



- Mass Name** = A text field entry to describe the weight
- Corresponding Pressure** = The pressure which is defined when used with the piston for which it was made, and under the gravity for which it was made.
- Makeup Mass** = A parameter not used with P3000 Series DWTs
- Adjusted Gravity** = The gravity for which the weight was made to be used. The screen shot shows the value for Standard International Gravity. This value is populated from the calibration report.
- Pressure Unit** = Populated from the calibration report.
- Mass Set Resolution** = The number of digits in (psi), also defined as the DWT resolution.

When the Mass Set Editor is new all fields are blank. Each weight is treated as a separate entity which requires separate actions of clicking on the “New” and “Save” buttons. The goal is to create individual weights which are grouped together as the “P3124 Weight Set”.

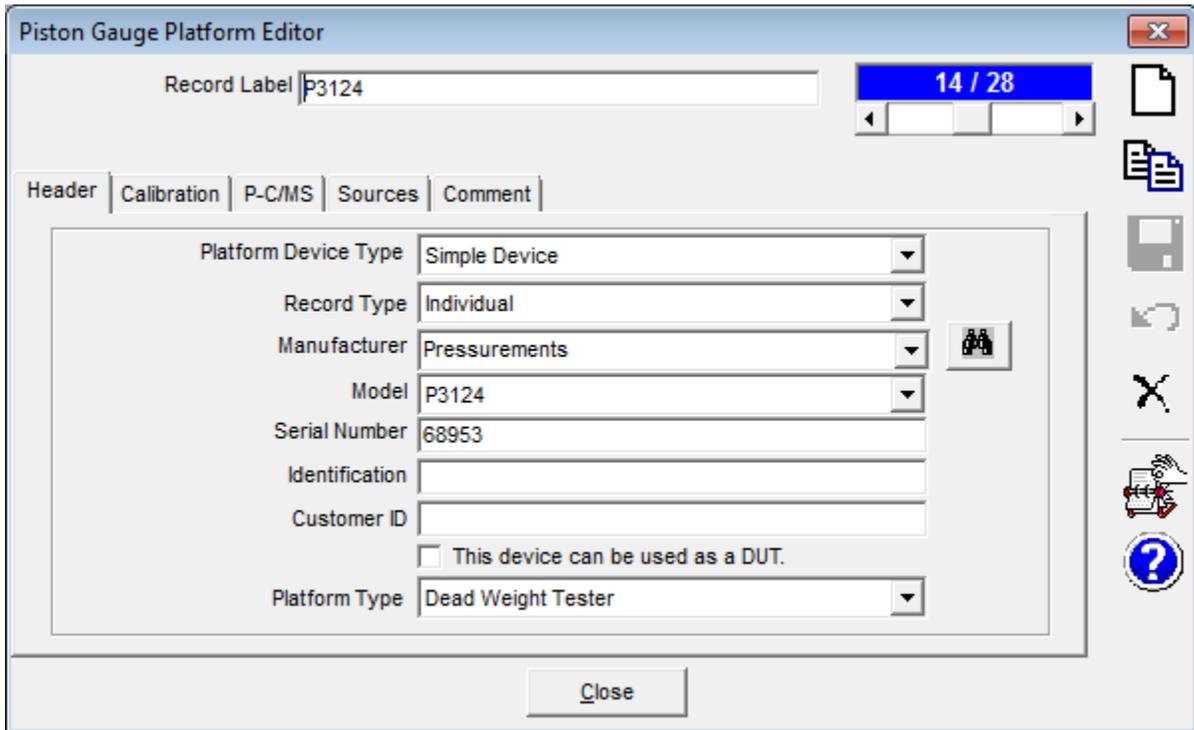


To create a new weight entry, click on the “New” button  in the middle of the window. Fill in the data for the weight, and then save using the “Save” button  in the middle of the window. To create the next weight entry, click the “New” button (in the middle of the window) again. Repeat this process until all weights have been defined.

The Tolerance Tab is optional.

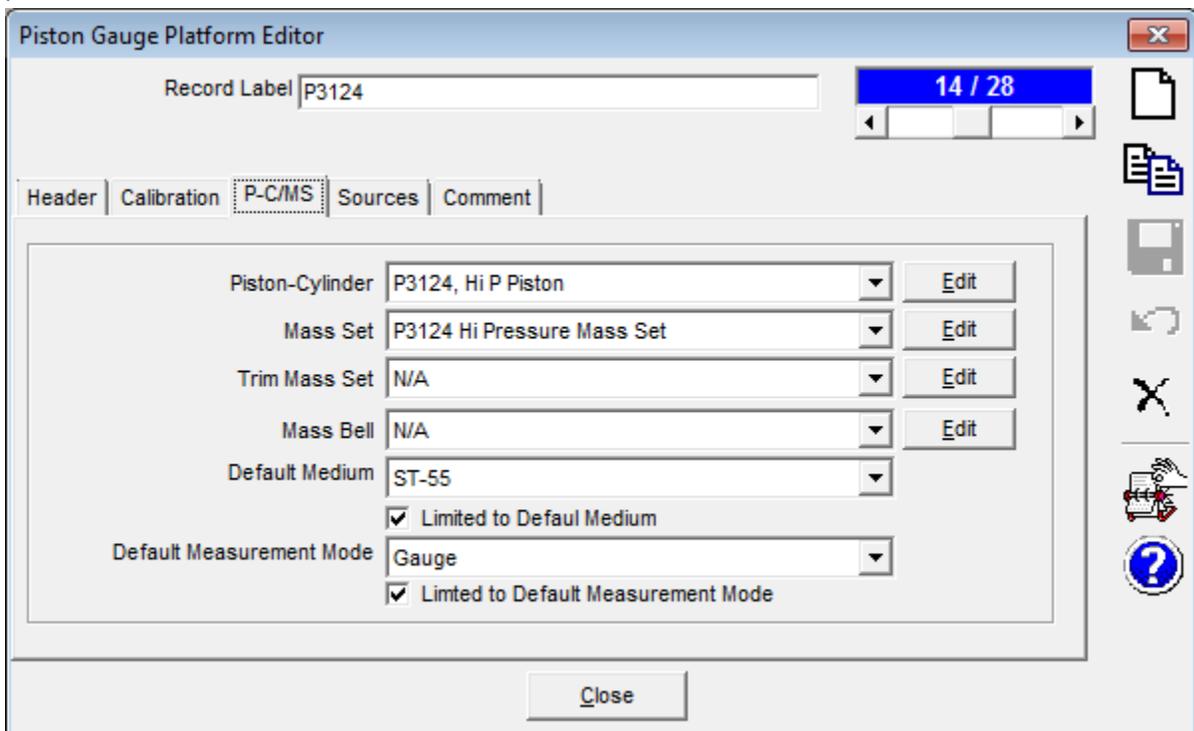
Creating the Deadweight Tester definition: [Setup],<Piston Gauge> → "Piston Gauge"

The critical selection is the "Platform Type". At a minimum only a serial number, Identification, or Customer ID is required for a valid setup.

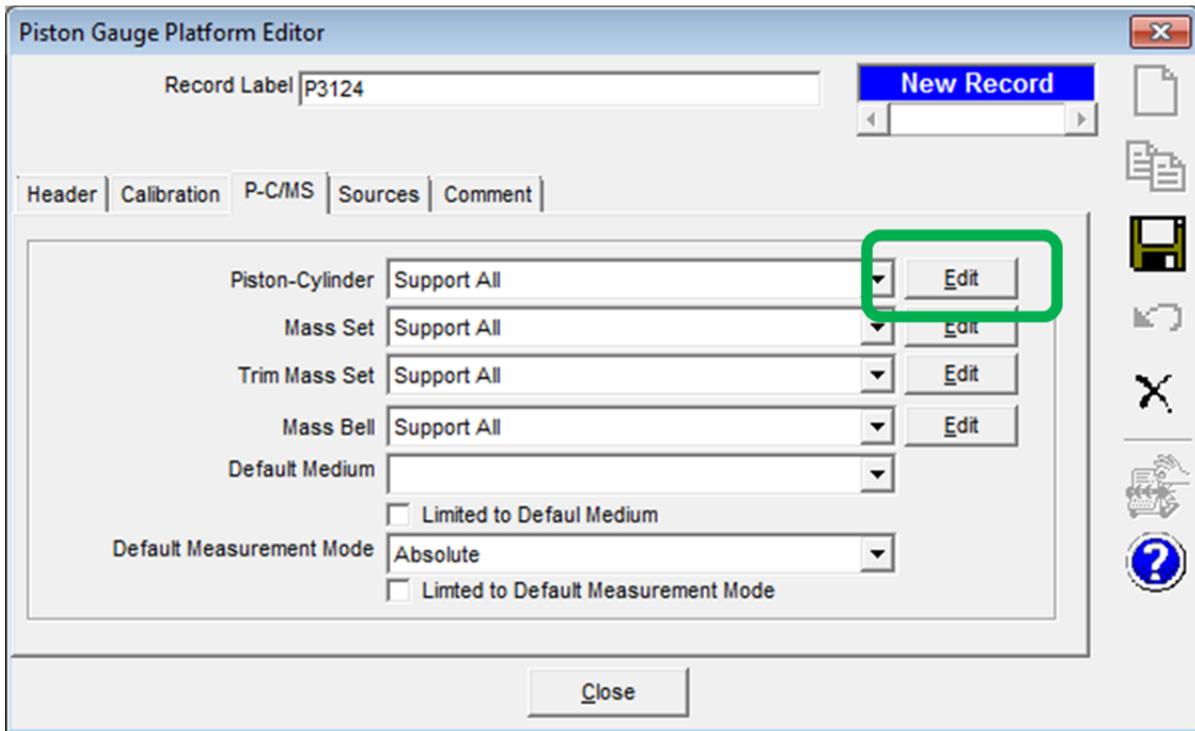


The fields in the calibration tab are optional, and are not required for a valid setup.

The P-C/MS tab is where the piston-cylinder and the weight set are assigned for use with the P3124 platform.



A new Platform Editor screen will have unpopulated drop down menus with “Support All” shown in them. The concept of “Support All” is to make every piston-cylinder and weight set in the database available for use with the deadweight tester. In many situations this is not ideal. For example you would not want to use a hydraulic piston-cylinder with a gas operated DWT. Therefore, the idea is to assign which piston-cylinder(s) and weight set definitions can be used with the platform.



Click on the “Edit” button to the right of the Piston-Cylinder field to select the “P3124 Hi P Piston”. If there is a definition for the low range piston (the P3124 model has both a Low and High pressure piston-cylinder) then select it at this time as well. Repeat the process for the Mass Set.

Trim Mass Sets are not typically used with a Deadweight Tester. The P3000 family of DWTs includes the Mass Bell as part of the piston-cylinder weight. Choose “none” for these selections. Choose the appropriate fluid medium and measurement mode.

The fields in the Sources tab are optional, and are not required for a valid setup.

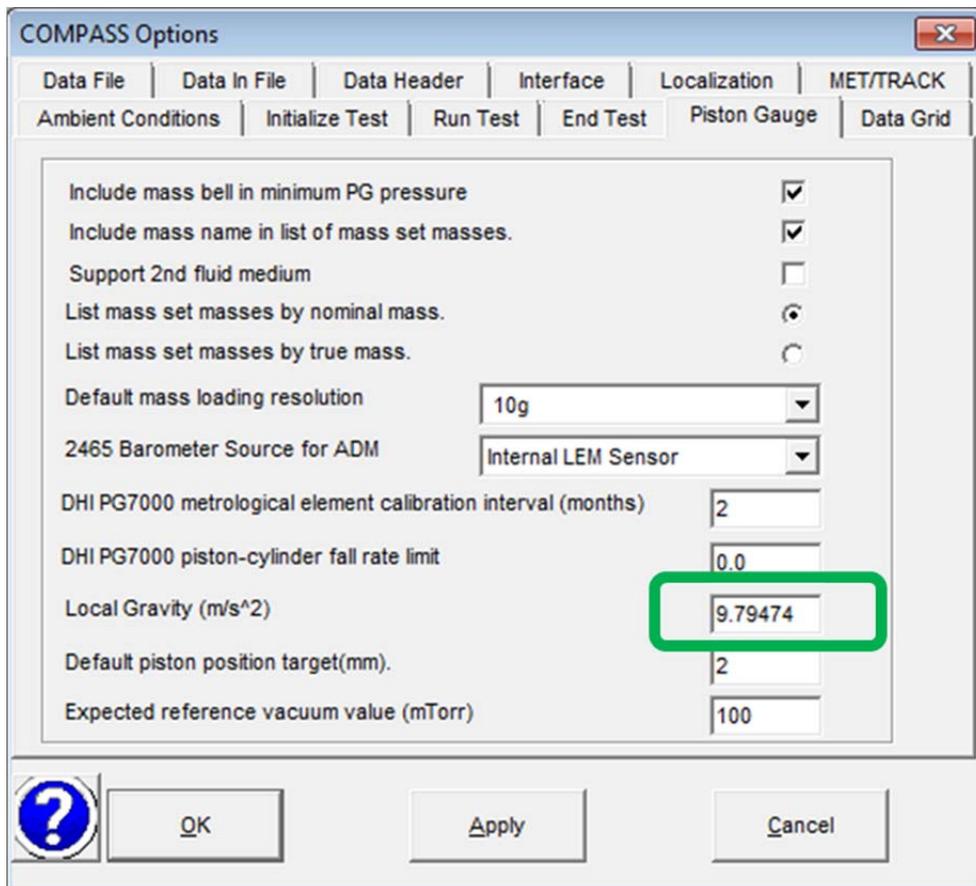
Configuring local gravity:

The biggest source of potential error when using a DWT is the difference between local gravity where the DWT is being operated and the gravity for which it was manufactured. In an ideal situation, the two values are the same. But in a common scenario of the DWT being used in a different lab or taken on the road for a mobile calibration job, the gravity values are different and a correction must be made.

The gravity correction is made as part of the COMPASS for Pressure “Piston Gauge Calculator” tool. The input for local gravity is located under the [Tools],<Options...> menu → “Piston Gauge” tab.

To be clear, this is the acceleration of local gravity for the location where the DWT is being used. The gravity value for the DWT itself is provided as part of the Weight Set and Piston-Cylinder definition.

An application note is available at www.FlukeCal.com to help determine local acceleration of gravity:
http://download.flukecal.com/secure/4218960B_EN_Accounting_For_Gravity_w.pdf?nvb=20140507200439&nva=20140507201939&token=0d431b7f84ff2c15956e9



When running a test the Piston Gauge Calculator tool is used to indicate the weights to load and the corresponding pressure. The “Pressure” field displays the corrected reference pressure for local gravity and a fluid head (if applicable). The ambient conditions fields are not used in the corrections, but are available for being logged to the data file.

The screenshot shows the 'Piston Gauge Calculator' software window. It features several input fields for ambient and test conditions, a 'Mass List' window, and a display for the resulting pressure and load.

Input Fields:

- Piston Gauge Platform: P3124
- Piston-Cylinder: P3124, Hi P Piston
- Mass Set: P3124 Weight Set
- Trim Mass Set: (empty)
- Mass Bell: (empty)
- Medium: ST-55
- Measurement Mode: Gauge
- Ambient Temperature (F): 73
- Ambient Humidity(%RH): 43
- Ambient Pressure (psi): 14.2
- Ambient Pressure Height (cm): 0.00
- Vent Height (cm): 0.0
- Head Height (cm): 0.0
- Test Gravity (m/s²): 9.80665
- Piston Position (mm): 0
- Local Gravity (m/s²): 9.794740
- Mass Loading Resolution: 10 psi
- Pressure Display Resolution: 0.0001

Mass List:

- Piston 200.0000 psi
- 20 psi #13 20.0000 psi
- 20 psi #11 20.0000 psi
- 20 psi #14 20.0000 psi
- 20 psi #12 20.0000 psi
- 100 psi 100.0000 psi
- 200 psi #7 200.0000 psi
- 200 psi #6 200.0000 psi
- 200 psi #9 200.0000 psi
- 200 psi #8 200.0000 psi
- 1000 psi_1 1000.0000 psi
- 2000 psi_3 2000.0000 psi
- 2000 psi_4 2000.0000 psi

Output Fields:

- Pressure (psi): 1198.5426
- Load (psi): 1200.0000

Buttons:

- Help icon (question mark in a circle)
- Pressure is Ready