How to set up COMPASS® for Pressure software

for use with Ruska Model 2400 piston gauges

Application Note

Summary

Support for Model 2400 piston gauge products has been fully implemented in COMPASS for Pressure 4.0 software, including the use of variables unique to the 2465, 2468, 2470 and 2485 piston gauges. COM-PASS software now allows direct import of users' existing WinPrompt software files for these piston gauges. Earlier versions of COMPASS for Pressure supported Ruska piston gauges, but with limits such as fixed units of measure on reference variables. This application note describes improved features found only in COMPASS for Pressure 4.0 or newer.

- COMPASS software solves the fundamental pressure equation using the Piston Gauge Calculator tool to determine the reference pressure as a result of a known force applied to the effective area of the piston–cylinder.
- Individual device definitions are created for each metrological element. For example:
  – Piston–Cylinder definition is created for each piston cylinder describing the effective area, mass of the piston, expansion characteristics, L1 variable, etc.
  – Mass Set definition describing the true mass and density of the individual mass pieces that comprise the mass set.
  – Mass Bell definition = "sleeve weight" describes the mass, density, and the hanger depth ("D") of the sleeve weight.
- Once the individual device definitions are created, then the Piston Gauge Platform definition is created and the individual metrological elements are assigned for use with a particular platform.

- If existing WinPrompt ".PC or .MS" files are available, COMPASS software has an import wizard to bring the metrological data into COMPASS device definitions.

What you will learn in this application note

- How to import WinPrompt *.PC and *.MS files with COMPASS
- How to set up COMPASS software for use with a Ruska 2465, 2468, 2470, or 2485
- How to use the Piston–Gauge Calculator tool

Requirements

The following items are required to implement this setup:
- COMPASS for Pressure Basic or Enhanced software, version 4.00 or newer

Ruska WinPrompt data import wizard

Skip ahead to the next section to create the device definitions manually if WinPrompt files are not available.

• [Setup], <Piston Gauge> ➔ Import Ruska PG file—an import wizard to convert WinPrompt .PC and .MS files into compatible COMPASS device definitions.

– The WinPrompt Configuration File selection must point to the location of the WINP32.ini file to correctly execute the conversion if the default WinPrompt units are to be maintained—enabled by selecting the "Maintain WinPrompt units" option.
– Click [Ok] and choose the file to be imported. From the "Files of Type" drop down menu select either Piston Cylinder (*.PC) or Mass Set (*.MS). Alternately, if there are multiple files in a common directory, then the entire directory can be imported and converted using the "Choose one directory" option.
– A message window will appear if the import was successful.
– Upon completion of the wizard, open the Piston-Cylinder or Mass Set Device definition to review for correctness of data by comparing against the calibration report(s).
• Importing a Mass Set
  – The process is the same as importing a piston-cylinder.
  – The import wizard separates out mass #1 from the rest of the mass set and defines it as the Mass Bell (Sleeve mass).

Create a Piston-Cylinder device definition

If WinPrompt files are not available then the Piston-Cylinder definition must be created manually. If a 2485 piston-cylinder is to be used, see the next section for additional information regarding the unique requirements for how COMPASS handles the piston mass.

• [Setup], <Piston Gauge> ➔ Piston-Cylinder—create a new Piston-Cylinder entry.

– Fill in the appropriate identifying information.
– Important! – choose "Piston Gauge" as the Piston-Cylinder type.

– **Calibration** tab information is optional; it is not required for a valid P-C definition.
– **Tolerance** tab – the nominal uncertainty of the P-C effective area. This information is optional and is not required for a valid P-C definition.
– **Characteristics** tab – critical information that describes the metrological characteristics of the piston-cylinder. Where information is not provided by the manufacturer, the field can be kept blank.
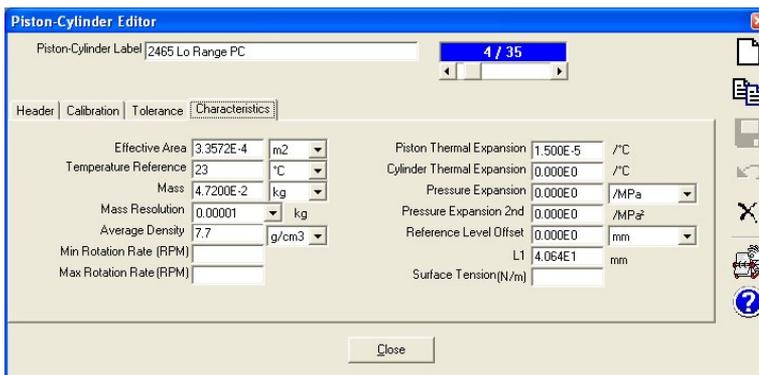
The Reference Level Offset is not the same parameter as "L1". The Reference Level Offset is unique to PG7000 / 9000 pistons that are semi-hollow. The L1 parameter accounts for the difference in reference level for the Ruska pistons whether they are semi-hollow or have a retaining nut on the bottom.

Be careful to select the proper unit of measure for each data field. Errors in values entered into the Piston-Cylinder [Characteristics] tab directly impact the calculation of piston gauge pressure.

True Mass values must be used. COMPASS for Pressure calculates the force component using the true mass values and corrects for buoyancy. Do not use "Apparent Mass" values as this will result in incorrect force corrections.

Create a Piston-Cylinder device definition – 2485

Many of the older 2485 systems provided a tare disk to be used with the piston-cylinder as a method to define the minimum mass of the piston-cylinder to a convenient nominal pressure value. In practice, the tare disk is always to be used with the piston-cylinder, and there are separate tare disks for each piston-cylinder. In addition, there is the Table Weight that is placed on top of the piston. The combination of the mass and density of the piston + table weight + tare disk are treated as a single entity by COMPASS. This affects older versions of the 2485, the newer 2485's were not supplied with a tare disk. If a tare disk is included, it is possible that the calibration data may report the mass and density as separate from the piston and the table weight. If this situation exists, then the mass of the piston must be reported as the sum of the mass of the piston + table + tare disk, and the average density of the three must be used.

- **Mass Set** tab—critical information that describes the individual mass pieces.
- The mass set is built by clicking the 'new' button (red high light) and entering the appropriate information about the mass piece. The finished mass entry must then be saved (blue high light) before the next mass piece can be created.

Average Density = (sum of the masses) / (sum of the volumes)

Where:
Sum of Mass = (mass$_1$ + mass$_2$ + mass$_3$)
Sum of Volumes = [(mass$_1$ / density$_1$) + (mass$_2$ / density$_2$) + (mass$_3$ / density$_3$)]

Be careful to review the Ruska calibration report to see if a sum of mass and average density is provided. This is sometimes reported as the "Total Tare". WinPrompt *.PC files use the Total Tare value for reporting of the Piston properties.

Create a Mass Set device definition

- [Setup], <Piston Gauge> ➜Mass Set—create a new Mass Set entry.
  - Fill in the appropriate identifying information.
  - Important! – choose "Piston Gauge" as the Mass Set type.

- **Calibration** tab information is optional; it is not required for a valid M/S definition.

- Repeat this process for each mass piece until the mass set is complete.

> True Mass values must be used. COMPASS for Pressure calculates the force component using the true mass values and corrects for buoyancy. Do not use "Apparent Mass" values as this will result in incorrect force corrections.

Note:
- The "Mass Name" field is a text field to identify the mass element. It is recommended that it be the same as the "Designation" used on the calibration report.
- The "Nominal Mass" field is an optional designation used with Fluke Calibration PG7000 / PG9000 mass sets for assisting with mass loading protocol. Generally, it can simplify interaction with COMPASS by providing an additional field of information to the mass list. A recommendation is to populate this with the rounded nominal mass value. COMPASS calculates the force component using the value in the True Mass field.
- Makeup Mass: Ruska mass sets do not have a Makeup Mass. (This is a convention used with Fluke Calibration DHI PG7000 / 9000 mass sets and with some Desgranges Type 5000 mass sets.)

Apparent Mass Conversion

Many calibration reports provide mass values in terms of Apparent Mass or Conventional Mass. COMPASS requires True Mass values. If the calibration report does not provide True Mass values then they can be calculated as follows: **Equation [** $Mass_{true} = Mass_{apparent} * ((1 - (\rho_{air})/\rho_{apparent\ mass}) / ((1 - (\rho_{air}) / \rho_{true\ mass})$

Example w/data [$0.1154392 = 0.1154110 * ((1 - 1.2) / (8400)) / ((1 - (1.2)) / (3100))$

Source data for example

As Left Mass Calibration Results - S.I. Units

Hanger Mass Depth (D): 4.928E-02 m   Standards: WM-03, WS-20

Designation	Density (g/cc)	Apparent Mass (8.4) (kilogram)	Apparent Mass (8.0) (kilogram)	True Mass (kilogram)	Uncertainty (kilogram)
1	3.10	0.1154110	0.1154118	0.1154392	5.8E-07
2	7.80	1.000004	1.000011	1.000015	5.0E-06
3	7.80	1.000016	1.000023	1.000027	5.0E-06
4	7.80	0.999995	1.000002	1.000006	5.0E-06

Note: density (ρ) units must be consistent, either "g/cc" or "kg/m^3" are acceptable.

Create a Trim Mass Set device definition

The trim mass set is optional and treated as an entity separate from the main mass set. COMPASS treats the trim mass as all pieces having the same density and the same tolerance (uncertainty).

- From the Mass Set Editor, create a new device definition and choose the mass set type as "Piston Gauge Trim Mass"

- Specify the sum of the trim mass and define the resolution of the smallest mass. The mass unit is fixed for grams.
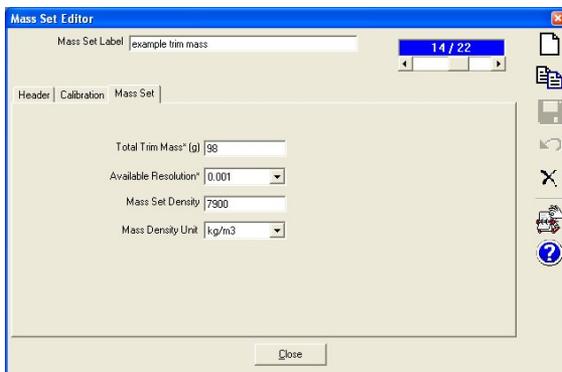
Create a Mass Bell device definition

Mass Bell = Sleeve Mass or Weight carrier. The Sleeve Mass is identified (designated) in Ruska calibration reports as mass #1.

- [Setup], <Piston Gauge> ➔ Mass Bell—create a new Mass Bell entry.
  – Fill in the appropriate identifying information.
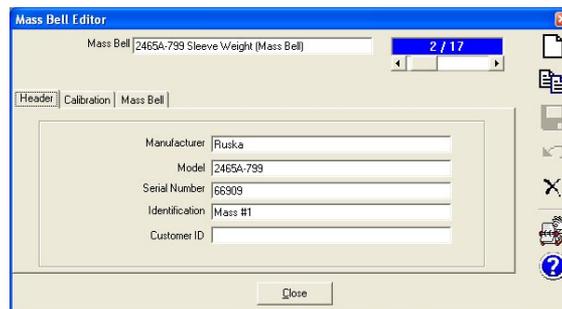
  – **Calibration** tab information is optional; it is not required for a valid definition.
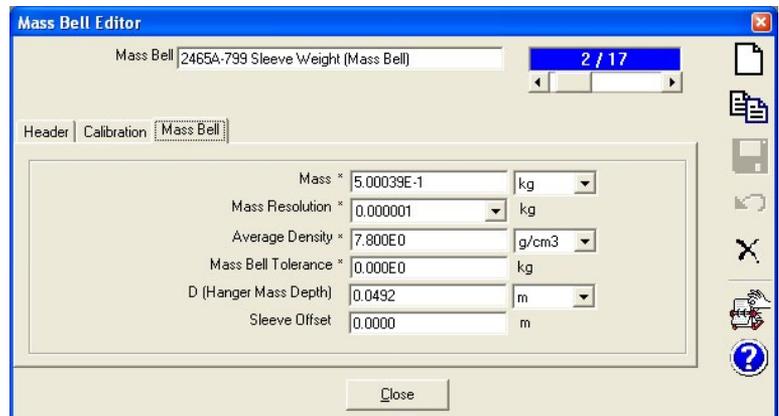
  – **Mass Bell** tab – critical information that describes the metrological properties.
  – COMPASS software supports both the old style (heavy) sleeve mass and the new light weight sleeve mass with the titanium ring.

– When using the new style light sleeve mass, a Sleeve Mass Offset height must be determined to compensate for small differences in the inductive float position sensor output when the mass load is using, versus not using, one of the larger 1 kg mass platters.
– To determine the value, place the sleeve weight on the 2465 base, record the FPI reading. Place mass #2 on, record the FPI reading and calculate the difference in the two readings.

Create a Piston Gauge Platform definition

The Piston Gauge Platform is the 2465, 2468, 2470 or 2485 base that generally consists of the mounting post, piston temperature sensor, float position sensor, rotation drive motor, etc. COMPASS uses the platform as an entity where piston-cylinders, mass set(s), and other outputs can be associated. The objective of defining the platform is assigning which metrological devices and other sources of output can be used with it.

• [Setup], <Piston Gauge> ➔ Piston Gauge—create a new Platform device definition.
  – Fill in the appropriate identifying information.
  – Be sure to choose "Piston Gauge" as the Platform type.
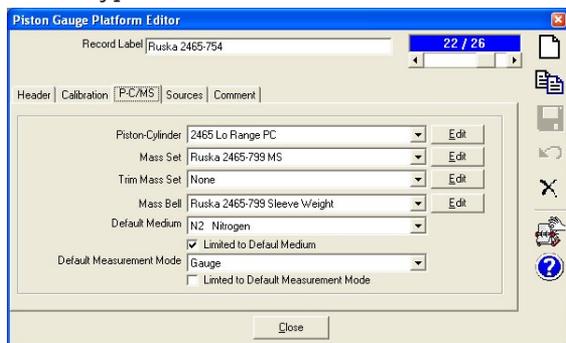
– **Calibration** tab information is optional; it is not required for a valid platform definition.
– **P-C/MS** tab = pick and choose which elements will be assigned for use with the Piston Gauge.
  – For a new platform definition, the drop down menu choices for the Piston-Cylinder, Mass Set, Trim Mass, and Mass Bell will default to "Support All". The idea is to limit the selections to those that are compatible with the Piston Gauge Platform.
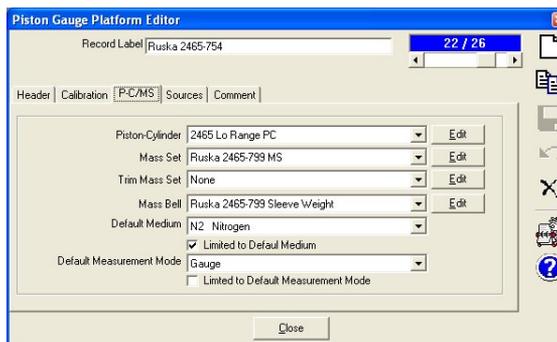
– Click the edit button to open a list of available piston-cylinders. Unless all piston-cylinders are to be used with the platform, choose "No" from the pop up window.
– Double click on the list of available piston-cylinders to select the desired piston-cylinder and to move them into the Piston-Cylinder Selector window. Click "Ok" to return to the platform editor window.
– Repeat the above steps for selecting and assigning of the Mass Set, Trim Mass Set, and the Mass Bell.
– Choose the desired options for the default medium and measurement mode.
– **Sources** tab = choose the source of input for reference vacuum measurement, piston-cylinder temperature, and piston rotation and float position data. COMPASS software solves the fundamental pressure equation correcting for influences to the reference pressure. The sources for these measurements can be manually entered into COMPASS software via the Piston Gauge Calculator. Alternatively, the measurements can be automatically fed into COMPASS software if the appropriate sensor and digital interface is available. The prerequisite is that these sensors must first be configured as COMPASS Support Devices. From the drop down menus, select the appropriate input source for the vacuum, temperature, position, and rotation speed.
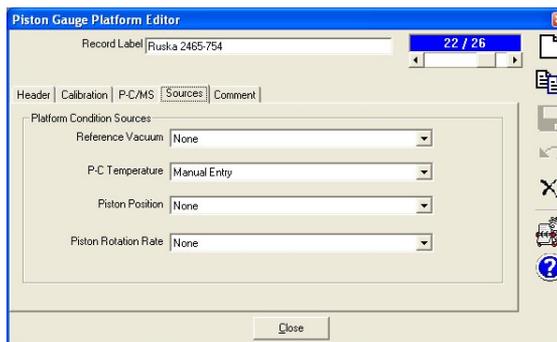
– **Comment** tab = optional field, the intent is record notes that are related to the device setup.

Using the Piston Gauge Calculator

[Tools], <Piston Gauge Calculator>
The PG Calculator is used to calculate the reference pressure for deadweight testers and piston–gauges. The tool can be used independently of any tests or it is automatically opened when a Test Definition or a Manual Test is started that requires calculation of piston–gauge pressure.

To use independently of a Test, start by choosing a piston–gauge platform—click the selection box to the right of the text field (red high light). Then make selections for the Piston–cylinder, Mass set, Trim, Mass Bell, and measurement mode.

To calculate a pressure:

- Select the Pressure field (green high light) and type the desired nominal target pressure, press ENTER on the keyboard to execute.
- Based on the active piston–cylinder, mass set, mass bell, and environmental/test conditions, the Piston–Gauge Calculator will calculate the true pressure at which the piston will float.
- A list of the required masses to load is available. If not visible, then click the Mass List button (orange high light). Intermediate level calculations are displayed on the lower half of the Mass List window.

To calculate a mass load: The Piston Gauge calculator performs Pressure-to-Mass and Mass-to-Pressure conversions. If a mass load is known (for example, as performing a cross float) then the mass load value can be input and the corresponding pressure value returned.

Units of Measure: many of the environmental and test conditions parameters can be used with units of measure of choice.

- Place the cursor over any of the labels for the parameters and if the cursor changes to a pointing finger, then the unit of measure can be changed. Click the label to effect the change.
- For example, if "kPa" is not preferred for Ambient Pressure, then click the label and change to "psi". The value will not automatically convert to the new unit, so be sure to enter in the new appropriate value in units of "psi".
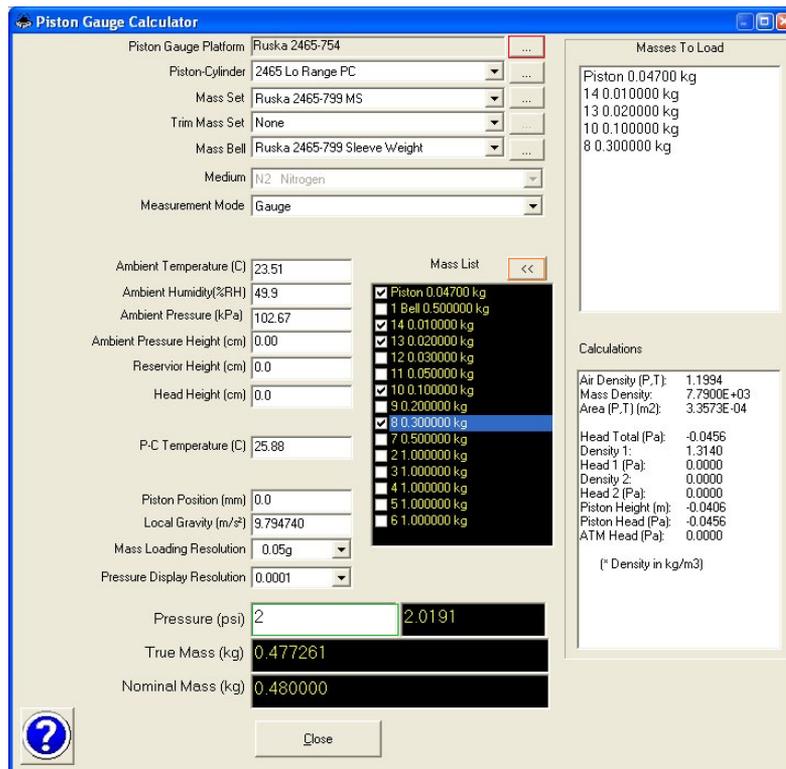
For more information

For more details about using COMPASS software, including information about the Piston Gauge Calculator that goes beyond the scope of this application note, please refer to the COMPASS software help file. To access the help file, when in COMPASS software click on the "?" help button on the bottom of the window.

Fluke Calibration. *Precision, performance, confidence.*™

Electrical	RF	Temperature	Pressure	Flow	Software