Starting the FPG Piston-Cylinder

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The process of starting an FPG8601 is a combination of installing the piston-cylinder and ensuring mechanical alignment of the piston with the cylinder. A misaligned piston is commonly referred to as a "toppled" piston, and a misaligned piston is frequently misdiagnosed as a dirty piston-cylinder.

There are four steps that must be met when installing the piston-cylinder ("P/C"). Follow these steps in order and make sure that each condition is met before moving on to the next step. If any of the steps do not pass, then there is no reason to go onto the next step. If the later steps do not pass, then back up to the previous step.

1. STEP 1: Verify FPG balance stability
    - Before the P/C is installed, observe the output of the balance for stability.
    - Balance output should be stable to within ±10 N (should not fluctuate or drift more than 10.0 counts)
    - It is normal to have some fluctuations as the balance and gimbal ring assembly respond to subtle changes in room pressure.

2. STEP 2: Installation and Alignment
    - Install the P/C in the upper mounting post and allow it hang without the lower mounting post attached.
    - The balance output (N) should be about –200 to -230 N.

        NOTE: This value is a reflection of the force (mass) of the piston. Presuming there was a valid tare condition prior to the P/C being removed, the value should be around -200 to -230 N. Regardless of the number, important matter is that the number should be stable and repeatable.

    - Align the piston by applying a combination of "Method 2" immediately followed by "Method 4" as illustrated in the FPG8601 Operation and Maintenance Manual.

        NOTE: "Method 2" can be considered a coarse adjustment and "Method 4" as a fine adjustment.

    - Balance output should be stable to within ±10 N
    - Once stability is achieved, lightly strum the piston bearing or retaining nut ("Method 4") to induce a minor disturbance and see if the balance returns to the previous value. Repeat three times to ensure the piston alignment was not in a momentary, transient state.

3. STEP 3: Attach the lower mounting post

    NOTE: steps 3 and 4 should be quickly completed with minimal time between the two. When the lower mounting post is attached there is a tendency for subtle pressure differences between the upper and lower mounting post chambers to cause the piston to topple.

    - Attach the lower mounting post and observe balance output. The external components (vacuum isolation valve, CDG sensor, or the bypass manifold) do not need to be attached at this step.
    - The balance output should not change by more than ±10 N. It should still be around –200 to -230 N.

- If the balance output changes (and does not stabilize) when you attach the lower mounting post, then remove the mounting post and repeat step two.

4. STEP 4: Turn on lubrication gas
   - Turn on the lubrication pressure. The lubrication pressure will increase from atmospheric pressure to 40 kPaa above atmospheric pressure (e.g.: about 98 kPaa to 138 kPaa.)
   - The balance output will increase from –215 N to about 25 N, and then slowly asymptote down towards 0 N.
   - If the balance output changes by several "1000 N" or gets very large, then step 4 fails, the piston has toppled. Go back and repeat step 3, or maybe back to step 2.

Within a few minutes you should be able to determine if the FPG output appears "stable enough". Typically, as it asymptotes down towards a new equilibrium it will fluctuate by a count or two. If this appears to be the situation, then reattach the external components. Allow 30 minutes for the FPG to reach a new equilibrium with the lubrication pressure, then perform the "60 Second Drift Test".

60 Second Drift Test

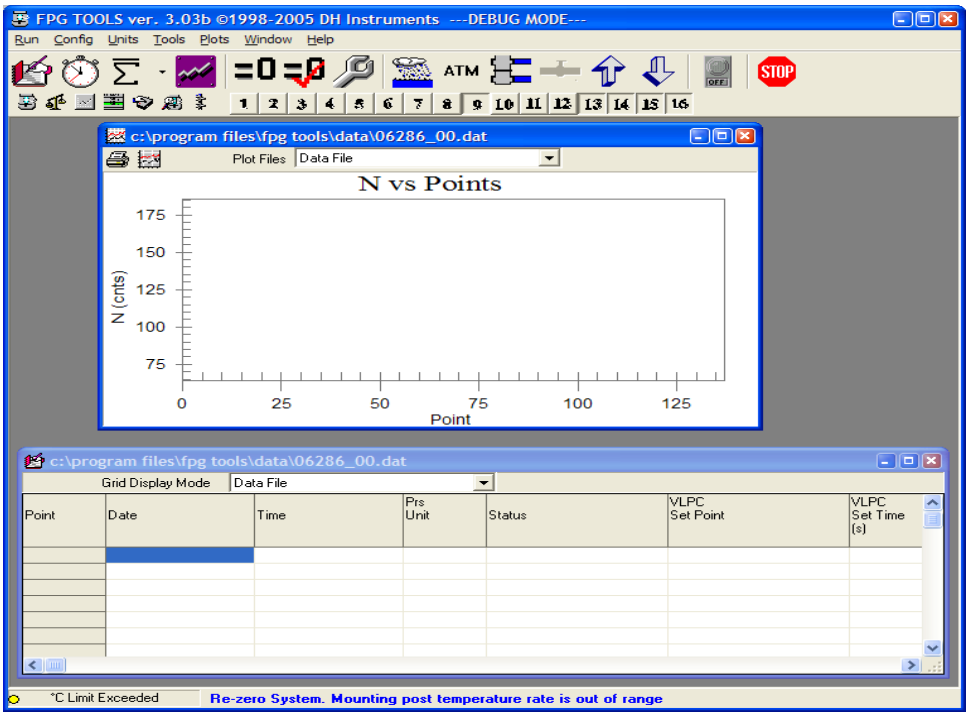
Objective: Quantify the stability of the piston-cylinder

The 60 Second Drift Test is to be performed in gauge mode after re-installing the FPG8601 piston-cylinder. The objective is to quantify and document piston-cylinder stability. The test is performed in gauge measurement mode.

Procedure:

- After installing the P/C and turning on the lubrication pressure, allow the P/C to equilibrate with the system for 30 minutes.
- The test is performed from with FPG Tools software.
- The scope is simply to log the FPG output for 60 seconds and look for balance output deviations of no more than ± 0.2 N (0.4 N peak to peak), or a 10 second period of no change in balance output.

From FPG Tools, perform the following menu selections:
1. [Run],<Run w/ Point Log…> This enables the data acquisition and will create a data file. Be sure to write down the data file name and path as it may be desired to look at the results.
2. [Plots],<Custom Plots> Select the "N vs. Points" plot and press the Plot Selection button.
NOTE: If the custom plot is not there, create a new custom plot by pressing the "create new custom plot" button, and then assign the "N" variable to the Y axis and the "Point" variable to the X axis.



3. Click the "stopwatch" button to start timed data sampling. Set the point delay for 1 second.
4. Allow the data sampling to run for 60 seconds, and then stop it by again clicking on the stopwatch.
5. Ideally, you want to achieve a level of stability where the N value does not change for 10-15 seconds. If this is met, then the piston is clean and stable. However, any 60 second period where the N values changes by no more than 0.4 counts peak-to-peak is acceptable.

Data Analysis:
If the FPG output does not meet the stability requirements, then the piston is either dirty or not centered. The stability criteria must be met before any further system diagnostics can be performed.

METHOD 1:

CYLINDER MANIPULATION

Hold the cylinder. Gently move it up and down while rotating it. The movement is very limited. Do not force it.

METHOD 2:

LIFT AND DROP

Put a finger under each of the piston retaining nuts. Gently lift the piston compressing the load limiting springs on the piston connecting rods. The movement is very limited. Do not force the piston up. Once the piston is up, let it drop down abruptly.

METHOD 3:

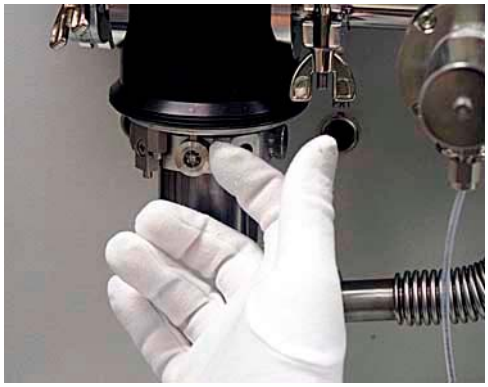
PULL DOWN AND RELEASE

Hold the piston retaining nuts. Gently pull the piston down compressing the load limiting springs on the piston connecting rods. The movement is very limited. Do not force the piston down. Once the piston is down, release it suddenly.

METHOD 4:

STRUM

Place an index finger on the circular bearing on the side of the gimbal ring. Lighly “strum” the bearing to cause a small amount of movement and let the ring return naturally. The movement is very limited. Do not force it.



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FPG Piston-Cylinder "Bounce" Technique

Objective: work out small residual pieces of particulate (lint) after a cleaning

After cleaning the piston-cylinder, it is very common to still feel slight hesitation with the piston-cylinder movement. It's possible that it might not be a cleaning issue, but perhaps an issue of a piece of lint or particulate stuck in the piston-cylinder gap. Before reinstalling the piston-cylinder, "bounce" the cylinder in an attempt to push out trapped particulate(s). The bounce technique has been found to be highly valuable for attaining N counts stability.

The technique:

- The piston-cylinder remains assembled
- With the p-c standing upright on the workbench, raise and lower the cylinder while rotating it around the piston
- Raise and lower about ½ to 1 inch, (any higher than this and the cylinder starts to rub on the piston and the feel can be confused for contamination)
- Pay attention to the feel, you are aiming for friction-free movement without the slightest reluctance of movement
- The act of raising the cylinder draws air into the tapered gap and expels it when the cylinder is lowered
- Flip the p-c over to the other end and repeat the bouncing. This process is iterative – sometimes the p-c must be flipped over and back over and bounced several times before the movement becomes free.