Configuring the A-0-A Seafloor Pressure Calibration System

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Summary:

This report describes how to configure and test the A-0-A Seafloor Pressure Calibration System (http://paroscientific.com/pdf/G8097_Calibration_Methods_to_Eliminate_Sensor_Drift.pdf).This in-situ calibration method has been developed to distinguish real earth movements from instrument drift. It includes a switching valve internal to the sealed housing of the OBS, PIES, or casing line that delivers ocean pressures to the Quartz Pressure Sensors. Periodically, the valve is closed to the seawater pressure, A, and vented to the internal housing pressure, 0. Reference calibration points at 0, as easily measured with a barometer inside the housing, are used to compensate for the drift at ocean depths, A.

Configuration:

Figure 1 is a block diagram of a demonstration A-0-A test system.

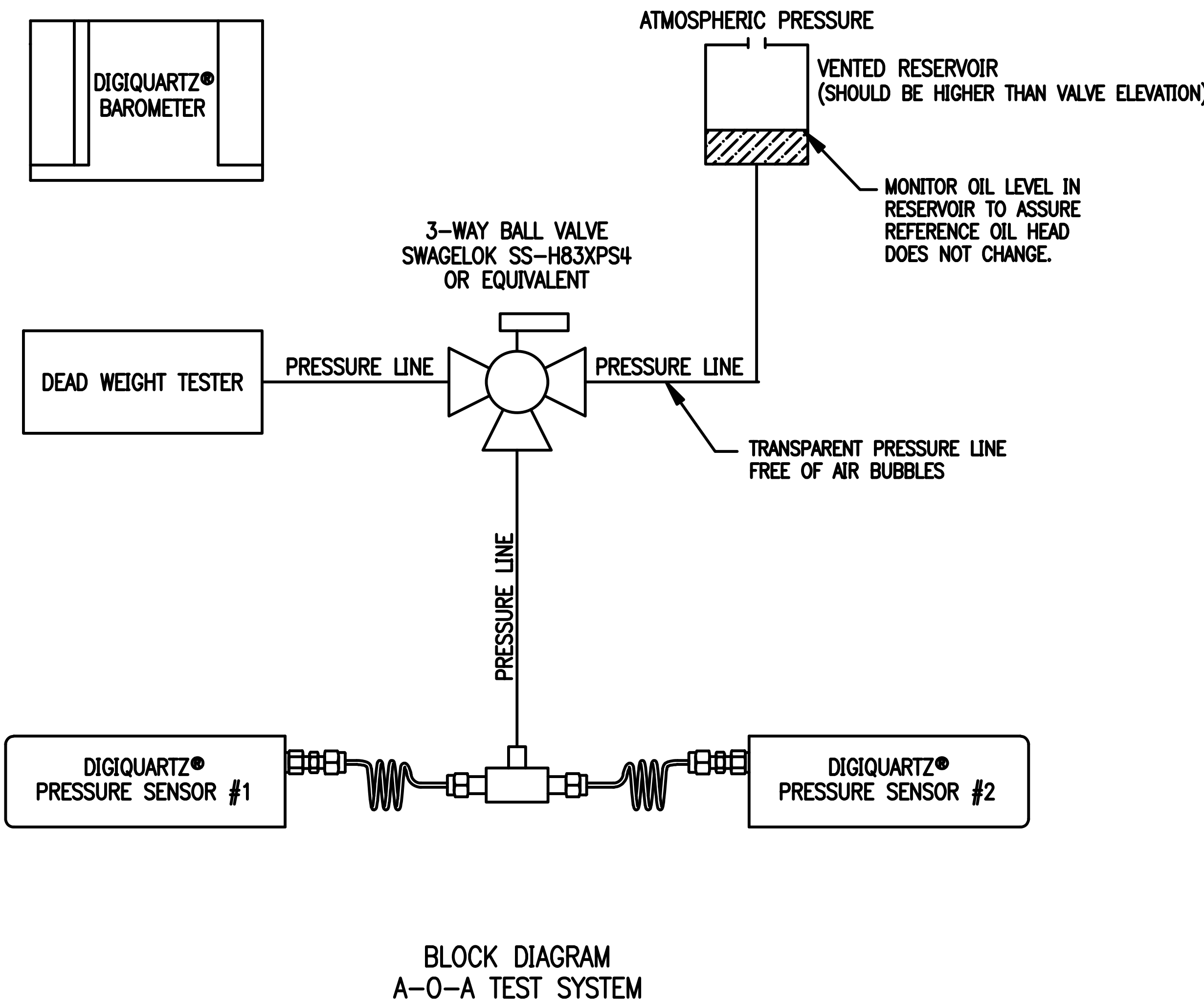

Figure 1

A demonstration A-0-A system unit was constructed per the block diagram of Figure 1.

The components of the demonstration system shown in Figures 2 are:

Two oil-filled Model 44.4K (3000 meters) pressure transducers with buffer tubes
1/8” Parker (2ET2-316) or equivalent ‘T’ pressure fitting
SSH83XPS4 Swagelok ball valve
1/8” clear nylon tubing and syringe used as reservoir with oil

Not shown are the hydraulic Dead Weight Tester (DWT) used as the precision pressure source, the nano-resolution electronic processing boards for the pressure sensors, and the Paroscientific Model 215A or 216B to measure barometric pressure.

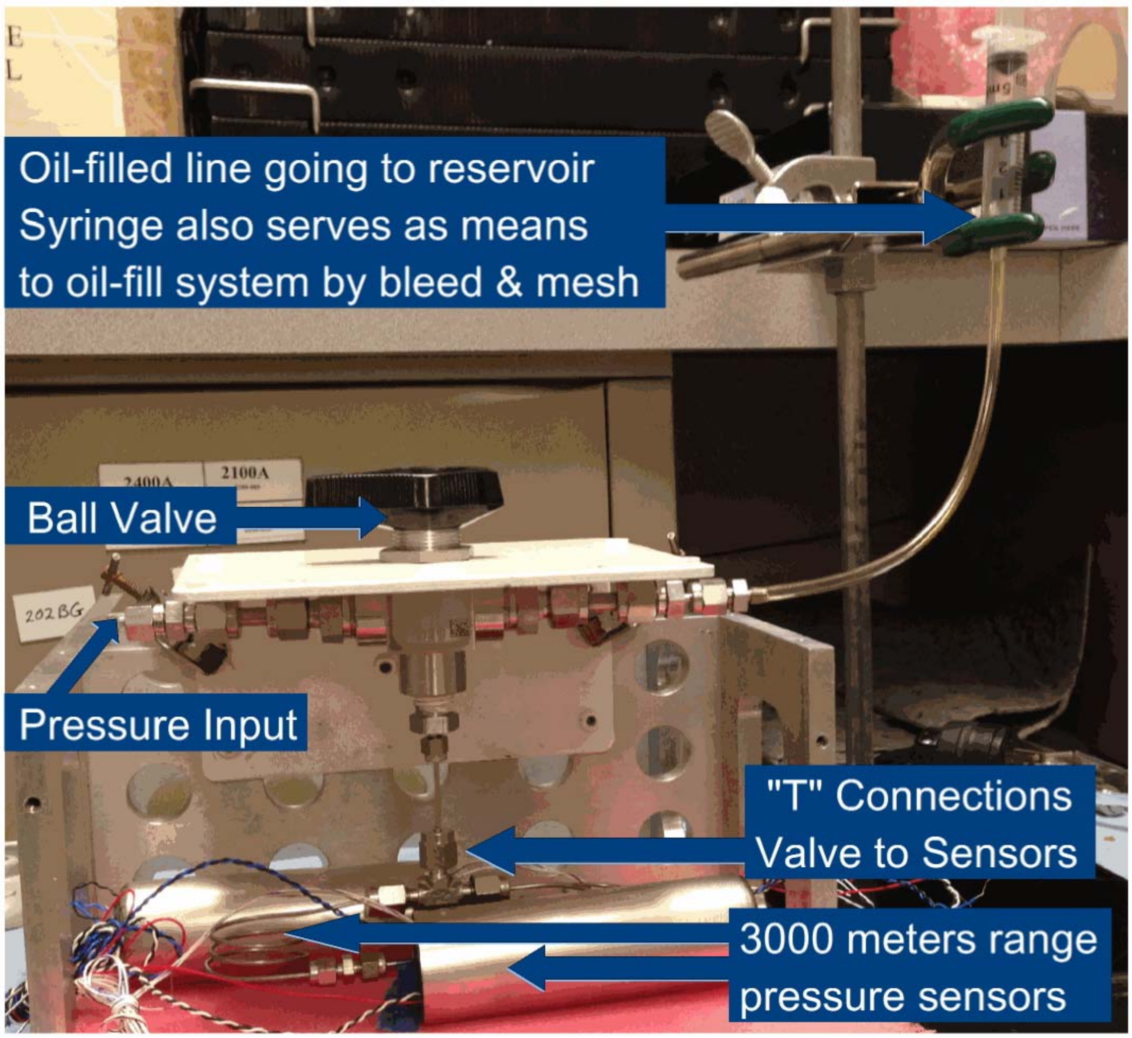

Figure 2

Assembly instructions:

The system must be leak-tight and there must be no air bubbles in the lines that could change the head of oil during A-0-A operation. Configure the system as shown in Figures 1 and 2. The oil reservoir is above the valve at the highest point in the system and the pressure sensors are at the lowest point. The pressure sensors are already vacuum oil filled by Paroscientific with FS1265 oil (See:http://paroscientific.com/pdf/G8108-001_Accuracy_Performanc_and_Handling_of_Oil-Filled_Digi_Pressure_Instrumentation.pdf). The ball valve should be vacuum oil filled using the following method and the pressure connections meshed without introducing air bubbles which could lead to measurement errors.

Vacuum Oil-Filling Ball Valve:

In order to ensure that the ball valve internal volume is filled with oil a vacuum oil filling technique is used. The ball valve is first evacuated to remove air from the assembly. Oil is then introduced to the ball valve as described below.

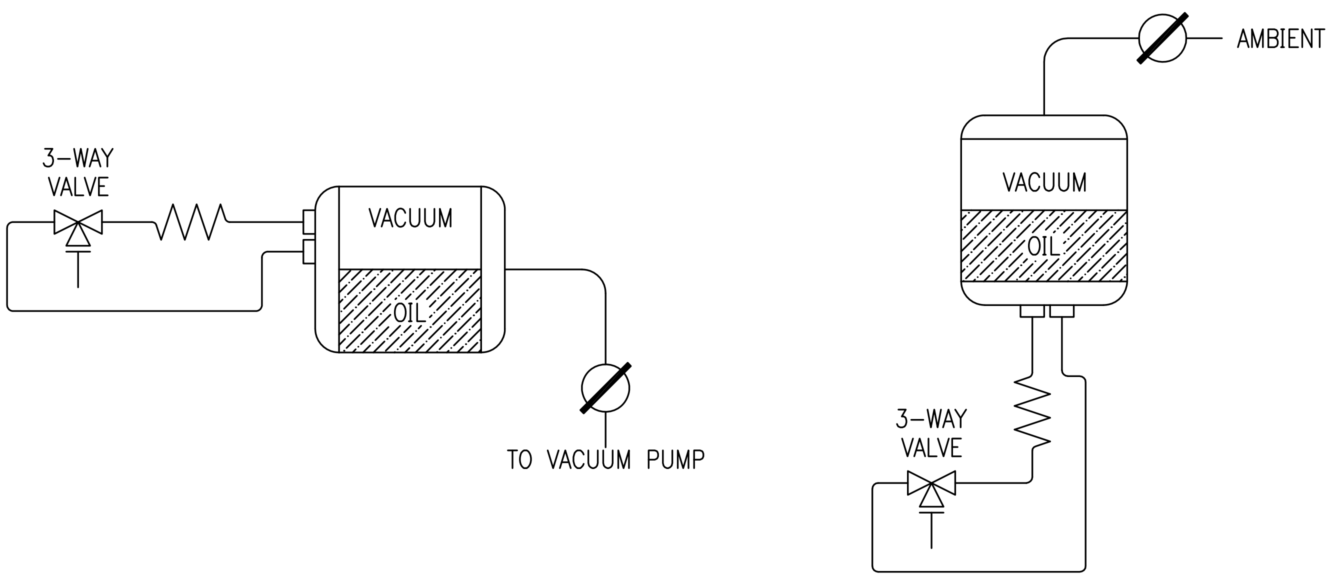

Figure 3

It is important to minimize the length of interconnect tubing when attaching the ball valve to the oil fill station. Install a cap or plug on the valve (shown as T in figure 3) and attach connections to the oil filling station (the valve should be open). This process will vacuum oil fill both sides of the valve at the same time.

For optimum results, the oil should be degassed for at least one hour. Open the valve to draw vacuum on the valve. Once the vacuum is achieved (<0.1Torr) and no air bubbles are present in the oil, turn off vacuum pump and open the vent to introduce oil into the valve (figure 3). Note: Slight heating of the oil and stirring with a magnetic stirrer speeds up the process.

After oil filling the valve, disconnect the valve from the oil fill station and install the appropriate size caps or plugs on the valve assembly to prevent oil loss.

Position the sensors as shown in Figures 1 and 2. Loosely make (finger-tight) the pressure connections at the “T” fitting to allow bleeding and meshing of the oil.

Fill the “T” fitting with oil and mesh the connections. Top off the “T” fitting with oil after making the connection. Install the oil-filled valve on the assembly and remove the cap or plug from the bottom fitting on the valve (closest to the “T”). Tighten the fitting per the manufacturer’s recommendations. Remove the cap or plug from the fitting on the pressure input side and make the connection to the DWT. Rotate the ball valve open to the DWT and mesh the connection. Tighten the fitting per the manufacture’s recommendations. Install a cap or plug on the nylon tubing attached to the reservoir to prevent oil loss and fill the reservoir with oil. Rotate the ball valve open to the reservoir and remove the cap or plug on the valve and reservoir. Allow oil to flow from the reservoir and mesh the connection to the fitting on the valve. Tighten the fittings per the manufacturer’s recommendations. Adjust the oil level in the reservoir by adding/removing oil (choose a reference level).

Rotate the valve open to the DWT and pressurize the system to full scale pressure with the DWT and check for leaks. There should be no drop in piston height for at least 4 minutes. Re-tighten the connections if leaks are found and repeat the pressure test.

Maintain full scale pressure to the transducers and rotate the valve to the reservoir. There should be no air bubbles in the nylon tubing. If there are air bubbles rotate the valve back to the DWT (which is at full scale pressure) and then back to the reservoir (atmospheric pressure) until no air bubbles are visible in the nylon tubing.

Testing the A-0-A Demonstration System:

A test was conducted on the system that simulated 2 years of weekly A-0-A calibrations. Over 100 actuations of the valve accumulated 4 milliliters (cc) of oil. If the reservoir is 10 cm diameter, then 2 years of weekly calibrations would change the level by 0.05 cm. The level change is negligible.

Tests were run to determine pressure changes caused by valve operation. Full-scale pressure of 4400 psi was applied from the DWT through the ball valve to the pressure sensors. The ball valve was then closed and opened to determine the magnitude of the pressure changes due to the valve operation. As shown in Figure 4, the magnitude of the pressure change was a negligible 16 psi.

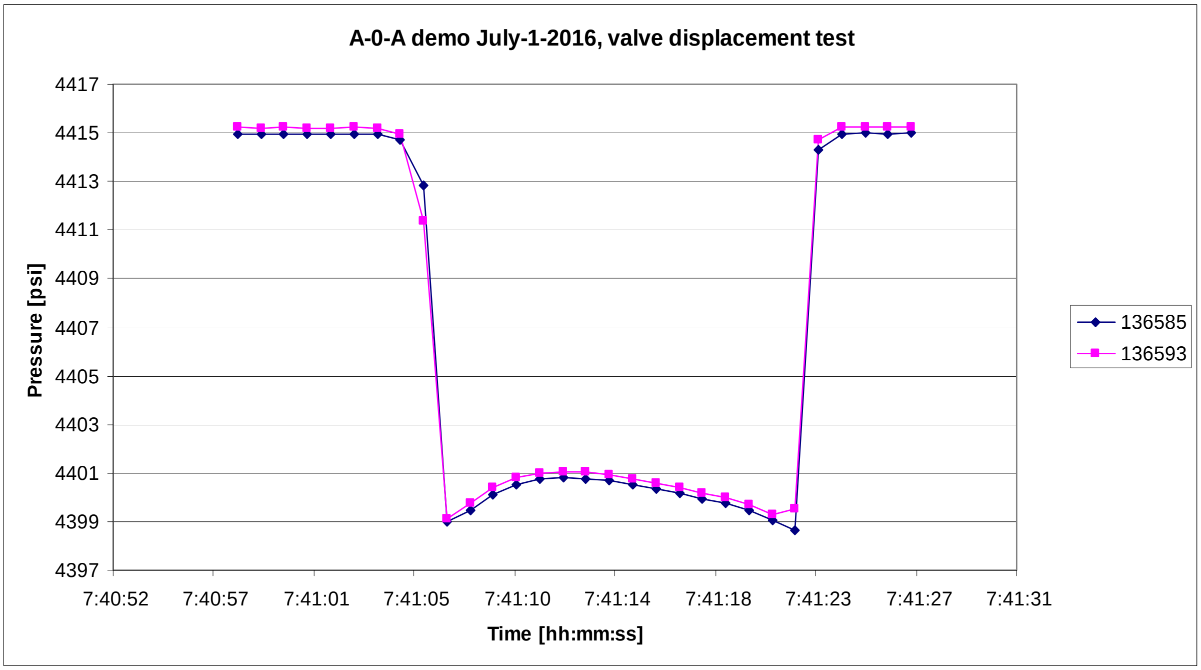

Figure 4

A needle valve, HIP 60-12HF4, was inserted between the DWT and the pressure sensors. As shown in Figure 5, needle valve operation caused a pressure increase of 35 psi.

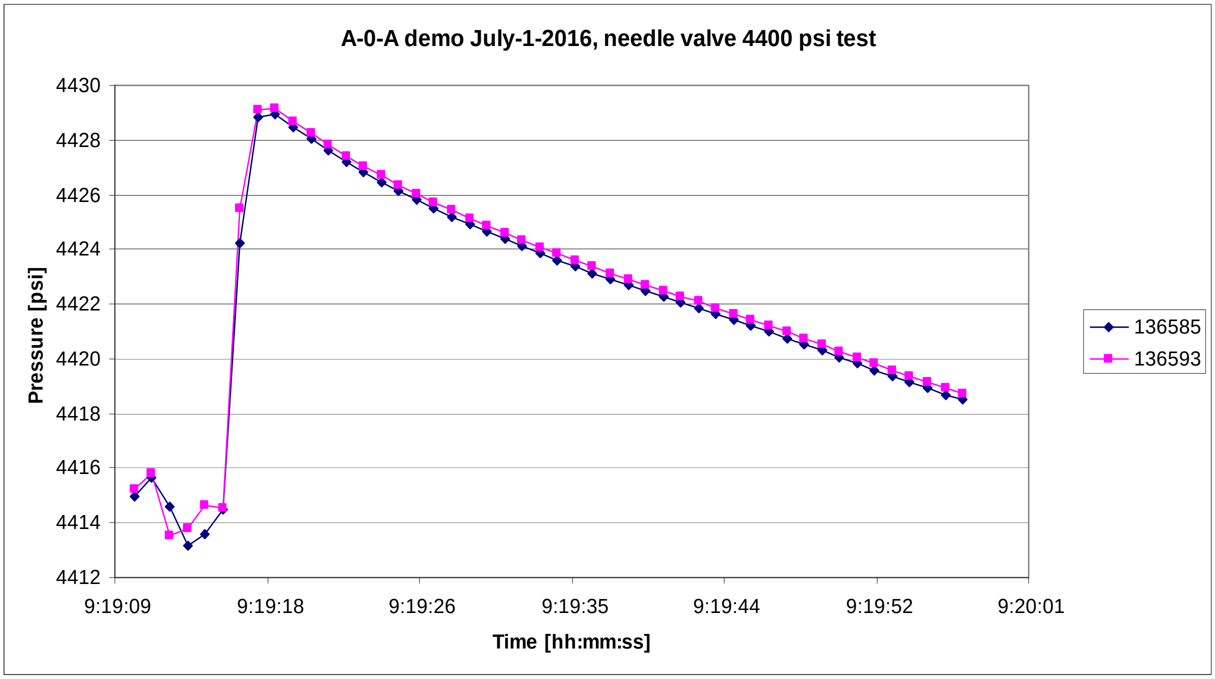

Figure 5

The sensitivity at full-scale pressure (3000 meters of water) was monitored by observing the fluctuations in the delivered pressure from the primary standard DWT. The fluctuations in the delivered pressure are about 6 ppm of full-scale and periodic with the rotation of the weights on the DWT. In Figure 6, the curves for the pressure sensors are offset to show that the two sensors closely track the applied pressure from the DWT.

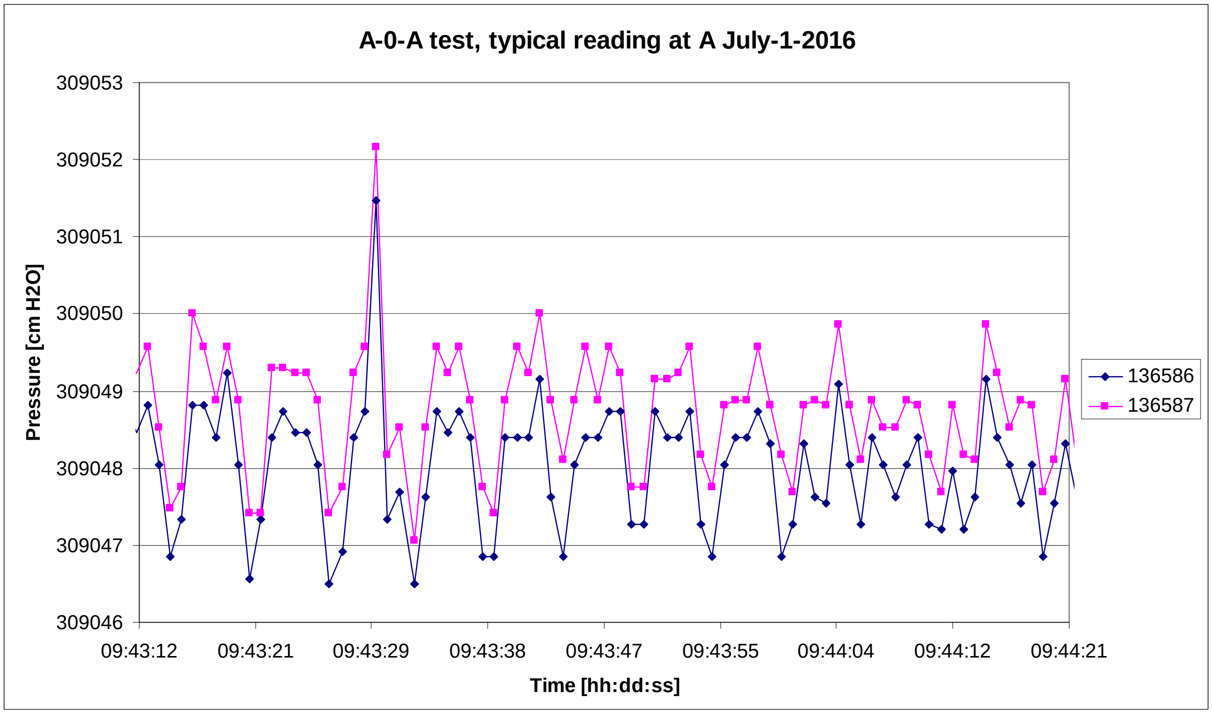

Figure 6

The sensitivity at atmospheric pressure was determined by adding drops of oil into the reservoir for the 0 readings. See Figure 7.

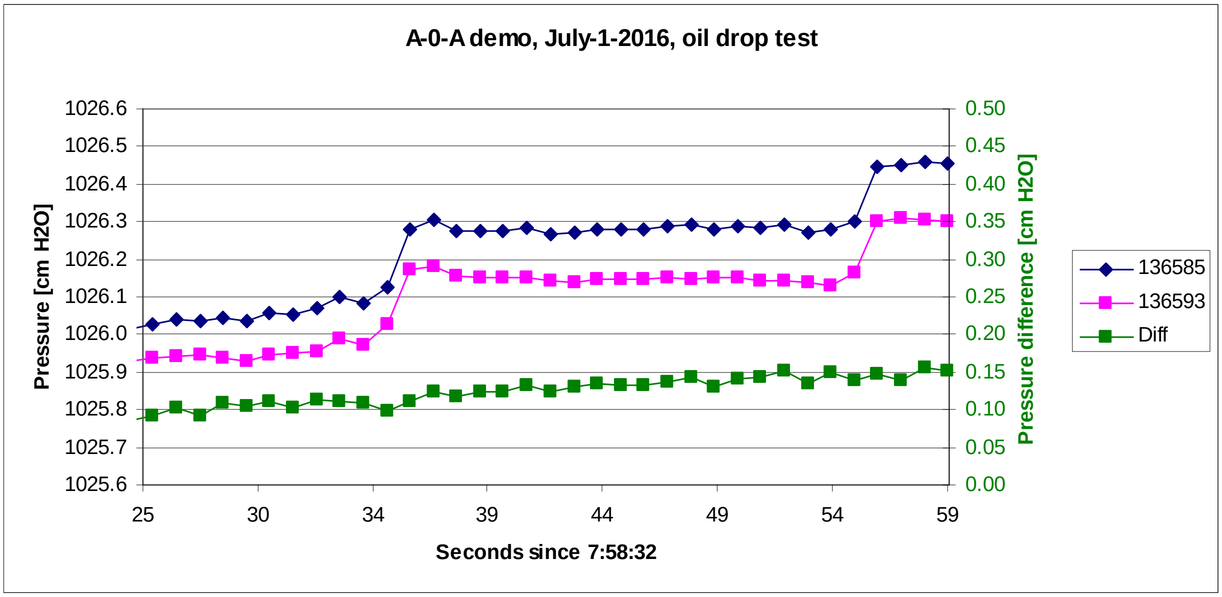

Figure 7