Water Level Transducer Calibration checks: Use of the Pressure Calibrator

Overview

The Ametek Crystal Pressure HPC40 pressure calibrator is used to check the calibration of any pressure transducers. Calibration checks shall occur annually, and remain valid for 18 months.

Calibrator

The HPC40 pressure calibrator has 3 main parts, the main unit – consisting of the display and reference elements (a 3 bar and 10 bar element), the pressure pump – including a bleed valve and fine adjustment knob, and the connection lines. Detailed instructions on the use of the calibrator are available from:
\\ares\hydrology\Hydrology Sites\General Site Information\Manuals\hpc40-series-manual-us.pdf

Setup

Connect the pressure pump to the correct pressure element on the main unit, then connect the transducer to the remaining port on the pump unit. The attachments should only be done up finger tight, not cranked as tightly as possible. Additional tightening may be needed if the pressure is unstable at full range. Ensure the Pressure calibrator is reporting in the correct units, if in millimetres, this must be **mmH2O at 4ºC**.

Method

Test the full range of the transducer, and record both the sensor response, and the calibrators applied pressure in the appropriate columns in the data tab of the spreadsheet located at:
\\ares\hydrology\Hydrology Sites\General Site Information\Druck Calibration\Calibration Template.xltm

Note: For Sutron checks, ensure you have recorded all of the "m values" listed in the data tab before carrying out the pressure checks.

Start the test at Zero applied pressure, and the vent valve fully open, compare these readings noting them in the calibration template, apply full pressure and note the two values again. Return the unit to zero applied pressure, and continue the checks across an evenly distributed range of pressures both in increasing and decreasing steps, the final two measurements should be a final full range test followed by a zero test.

If a calibration check requires using the 10 bar element, carry out a test to the full range of the 3 bar element, and then repeat the test going to the full sensor range using the 10 bar element. Treat these as two independent tests, they can then be combined to see the sensors overall performance.

Results

The collected data shall be stored using the calibration template:
\\ares\hydrology\Hydrology Sites\General Site Information\Druck Calibration\Calibration Template.xltm

In the summary tab, add all relevant information relating to the transducer, including the site the calibration applies to – If the transducer was swapped out of a site, the calibration is recorded against that site, **not HRC Store.** You can select the commonly found variable such as transducer type, output, and pressure range from drop down

menus. Double check that all the sensor and site information is correct before saving the file in the "Calibration" directory using the naming convention: *XXX_<sensor type>_<serial number>_<date>.xls*x

Sensors removed from sites should be stored against the site they were removed from with a note detailing when it was removed. Re-spanned sensors should be stored with the three-letter site code STR with the naming convention above. New instruments will be conformance tested before deployment and stored using the three-letter site code "NEW".

Calibration results

Archiving of calibration files is the responsibility of the individual, care must be taken to ensure that all of the necessary and correct information has been recorded, and that the results are of suitable quality to define the sensors performance. Where doubt or error exists, the sensor shall be re-tested and the portfolio holder consulted before archiving (save data in the raw directory).

In determining the Pass/Fail status of a transducer, the residual plot is used. This plot will show if a sensor deviates from manufacturers specification, the regression analysis and residual graphs will characterise the nature of any deviation. If the results of the test are within the manufacturer's specified limits of that sensor, it is deemed "Passed" and is suitable for redeployment. Failed sensors should be further tested as to the nature of the failure and, once confident in the sensor performance, can be re-spanned or otherwise sent away for repair. Sensor-specific procedures for dealing with non-conformances and failures are found in the appendix of this procedure. A Non-conformance report shall be raised identifying the site the sensor is from, and the nature of the failure.
Sensors suitable for Groundwater deployment only shall be calibrated and labelled as such.

Water Level Transducer Calibration checks: Use of the Pressure Calibrator

Sutron Calibration

Checking the calibration of Sutron pressure transducers involves the use of additional software and commands. The software commonly used is Tera Term, this software can be found at:
\\ares\hydrology\Hydrology Sites\General Site Information\Software\Programs\TeraTerm

Apply power to the Sutron, and connect your computer to it the unit's serial port. Run Tera Term, choose serial connection and click OK, then: *Setup > Restore Setup > Sutron.ini*
The program will now be communicating with the Sutron, and returning measurements. From the terminal window you can now input commands and receive responses from the device and carry out the calibration check as per the procedures outlined previously in this document.

Sutron Commands

In carrying out calibration check, the following commands are used to get the information required for the calibration form:

?! – Address Check, this will return the specified address of the sensor, this address will be referred to as "**a**" in all commands. The Default is 0, in some cases this has been changed to avoid conflicts on site.

aI! – Send Identification: Gives the Sutron firmware and serial numbers, useful for checking serial numbers that are worn or not visible

The Following commands are carried out at the beginning off a calibration check, and are recorded on spreadsheet. After entering the command, wait for the sensor to respond with **a**, the user can then enter "**aD0!**" to display the response.

aM! – Measure, this command takes and reports a measurement of the current pressure that is being detected by the unit with offsets applied

aM1! – This requests the current raw measurement in PSI

aM2! – This requests the sensors ambient temperature reading

aM3! – This requests the User scale, offset, and field calibration. The unit will respond with **a003**, **00** is the time, in seconds, that the measurement will be available in and **3** is the number of values. E.g.

0M3! Request data
0003 Unit responds
0D0! Report data
0+2.3073+0.0000000+0.00000 Unit responds with the measurement – in this case, it shows the standard slope (2.3073), and no offsets applied (+0.0000000 + 0.00000)

aM4! Returns the Standards Lab calibration – this command works much the same as the **M3!** command, but reports **aso** where **s** is the scale (default is 1) and **o** is the offset, in psi, (default 0)

Re-zeroing and re-spanning Sutrons

The following commands are used to apply offsets to sensors for accurate zero readings, and slopes to correct readings across the full range of the sensor.

Zero correction

aXS! – This command lets the sensor determine the offset from a stable pressure source. **aXS!** Will calculate the offset with the sensor vented to atmosphere, a zero applied pressure state. This is the simplest method of applying an offset correction.

Slope

When a sensor has failed calibration check due to a slope error, it can be re-spanned. The calibration results can be used to show what corrections need to be applied. The regression analysis results from the failed calibration can be used to determine what corrections need to be applied.

Determining the slope to be applied

A unit has the following **current** slope, offset, and regression analysis:

Comments	Sutron Slope and Offset :0+70.20673+0.000000-0.3147		
Regression Analysis			
Constant	0.0000	0.0004	0.0034
Slope	1.0005	1.0005	1.0000

To calculate the slope required for a re-span, take the current slope of 70.20673, and divide it by the middle slope value of 1.0005 to get **70.171644**

We now need to enter this slope into the unit.

To enter a user-defined slope two steps are required, first the sensor must be set up to accept user defined units:

aXUP+n+d!

Where **n** defines the units and **d** defines the number of decimal places.
Input **aXUP+9+2!** To set a unit to accept a custom slope and offset.
Now, custom data can be entered.

aXUU+s+o!

This is used to load the user-defined slope and offset where **s** = the slope, and **o** = the offset

Using our calculated slope, we can enter the command
aXUU+70.171644+0-0.3147!
The unit will respond, we then enter **0D0!** And the result will be displayed. We can check this again via the **M3!** Command.

Water Level Transducer Calibration checks: Use of the Pressure Calibrator

Once the slope and offset have been corrected, we must then run through a complete calibration check of the unit to characterise its performance with these new settings. This check is saved under the STR site name as outlined in this document.