RST INSTRUMENTS LTD.

Pneumatic Piezometer Installation Manual

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Product: Pneumatic Piezometer Installation Manual

Document number: PPM0027A
Revision: A
Date: March 28, 2012

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1 INTRODUCTION

Pneumatic piezometers are used to measure pore water pressure in boreholes and fills. A typical pneumatic piezometer system includes the following components:

- Pneumatic Piezometer
- Tubing and Quick-Connect Fittings
- Pneumatic Readout

Pneumatic Piezometer: The piezometer is sealed in the borehole, embedded in soil, or suspended in a well.

Tubing: Pneumatic Piezometers use twin tubing which carries gas to and from the piezometer.

Pneumatic Readout: The RST Pneumatic Readout is a portable pneumatic indicator which is carried to the readout station. The readout has an internal supply tank which holds the compressed gas (usually water-pumped nitrogen or carbon dioxide) which is used to activate and read the piezometer.

2 RST ADVANTAGES

- Over 22 years of proven, long term reliability and accuracy.
- Lowest displacement pneumatic piezometer available (0.002cc).
- Low cost.
- Standard accuracy – 0.1% F.S. with the RST Pneumatic Readout.
- No internal metal parts. All piezometer components are non-metallic corrosion-resistant nylon. Flow or non-flow methods supported.
- Compatible with most brands and readouts.
- In-line ***filtered*** quick couplers which prevent dirt from entering the system.
- Remote readings via flexible direct burial tubing avoids construction obstacles.
- RST twin-tube pneumatic tubing uses a compression molded jacket rather than PVC. This jacket combined with a central web adds strength and reduces void space. Reducing the void space prevents the tubing from becoming a water conduit, should a small nick or cut occur in the jacket.

3 PRINCIPLE OF OPERATION

RST Pneumatic Piezometers are operated by pore-water pressure acting on a diaphragm. This pressure is balanced by gas pressure (usually nitrogen) applied externally through tubing from the surface. When the applied gas pressure exceeds the pore-water pressure acting on the reverse side of the diaphragm, the diaphragm moves outward and allows flow along a return line. When the return flow is detected, the gas supply is shut off at the inlet valve. Any pressure in the tubes greater than the pore-water pressure bleeds away, and the diaphragm returns to its original position. At this point, a null-balance condition is achieved and the gas pressure, which equals the pore pressure, is read on the input tube by the readout instrument. Since interaction between the tip and the surface is by gas flowing through thin tubing, pneumatic piezometers are unaffected by frost penetration at the surface. During installation, however, enough slack should be included in the line to provide for differential movement and seasonal heaving. For further information on reading pneumatic piezometers, please refer to the RST Pneumatic Readout Manual.

4 P-100 MINIATURE PNEUMATIC PIEZOMETER

The model P-100 is a general purpose piezometer incorporating a 50 micron stainless steel filter. This instrument is capable of monitoring pore pressure from 0-13 800 kPa (0-2000 psi). The P-100 combines the features of high accuracy and reliability, small size, low cost, and extremely low displacement, with the ability to be constantly monitored.

5 P-100-1 STANDARD PNEUMATIC PIEZOMETER

The model P-100-1 consists of a P-100 transducer encapsulated in a slotted PVC, sand filled, Casagrande type piezometer body. This body employs a protected 70 micron porous plastic filter, in addition to the P-100's 50 micron stainless steel filter.

The RST Standard P-100-1 Pneumatic Piezometer is the recommended general-use pneumatic piezometer. It consists of a P-100 transducer encapsulated in a slotted PVC, sand filled, Casagrande-type piezometer body. This body employs a protected 70-micron porous plastic filter in addition to the 50-micron stainless steel filter on the piezometer tip (Figure 1).

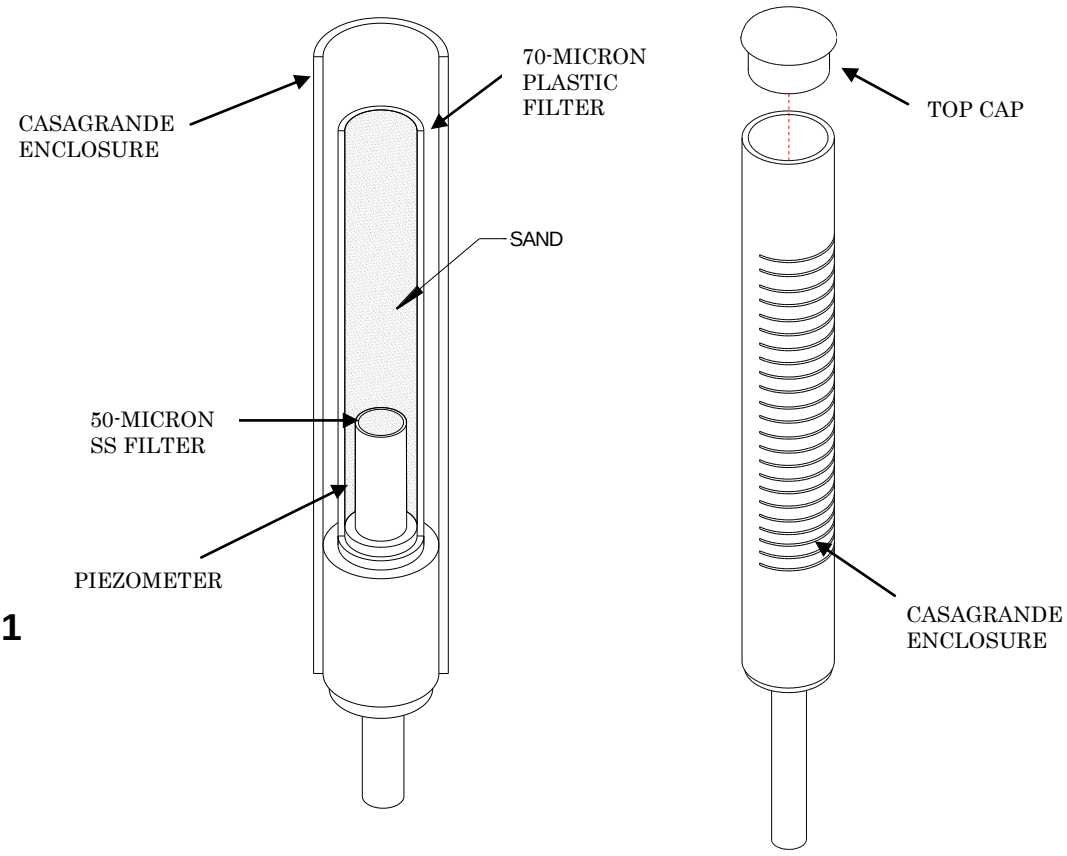

Figure 1

– P-100-1 General Arrangement

6 P-102-SS PUSH-IN PNEUMATIC PIEZOMETER

The P-102-SS Push-In Pneumatic Piezometer encloses a sealed P-100 transducer in an all stainless steel piezometer tip designed to withstand the rigors of push-in installations. As an improvement over small disc filters, the large 40-micron poly filter is in direct contact with the soil, and is removable for pre-saturation prior to installation. The first 1.5m (5ft.) length of the drive pipe is semi-flush coupled to aid in self-sealing. Standard thread connection is 1.25" NPT. Alternate threads such as CPT are optional.

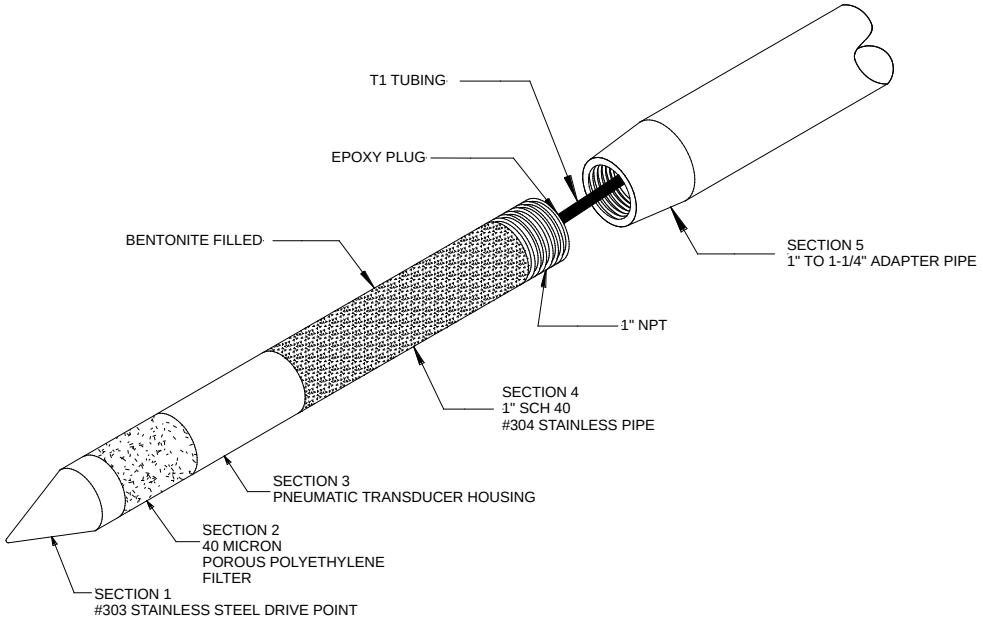

Figure 2 – P-102-SS General Arrangement

Specifications:

SECTION	DESCRIPTION	DIMENSION
SECTION 1 DRIVE POINT	45º STAINLESS STEEL DRIVE POINT.	LENGTH: 2" (.05 m) DIAMETER: 1.26" (.032m)
SECTION 2 FILTER	40 MICRON POROUS POLYETHYLENE FILTER.	LENGTH: 2" (.05m) O.D. RANGE: 1.26" (.032m) I.D. RANGE: 0.94" (.024m) AREA: 7.9 in^2 (.0051m^2)
SECTION 3 TRANSDUCER HOUSING	S.S. TRANDUCER HOUSING INCORPORATING A P100 PNEUMATIC PIEZOMETER.	LENGTH: 3.6" (.091m)
SECTION 4 STAINLESS PIPE	1" SCHEDULE 40 STAINLESS STEEL PIPE. THE PIPE IS BENTINITE FILLED AND TOPPED OFF WITH A EPOXY PLUG.	LENGTH: 10" (.25m)
SECTION 5 ADAPTER PIPE	1" TO 1¼" STEEL ADAPTER WELDED ON A 1¼" STEEL PIPE.	LENGTH: 48.25" (1.23m) FOR 5' PIEZO

7 INSTALLING THE P-100 AND P-100-1 PNEUMATIC PIEZOMETERS

7.1 GENERAL NOTES

- Always handle the piezometer with special care.
- Saturated, water-filled piezometers are prone to freezing in cold weather. Be sure to store piezometers above $0^{o}C$ to prevent damage to the instrument.
- Pneumatic tubing should also always be handled carefully. Avoid making small radius kinks or bends. Due not drag the tubing over the ground, this could create nicks and cuts in the tubing. Do not lay the tubing across roads where there is traffic.
- Be sure to mark tubing in order to identify it later. Also label depths on the tubing in order to easily recognize when the piezometer has reached its desired finished location.
- Always avoid damage to the quick-connect ends. It is important to keep them clean and dry. Any dirt in the fitting can create leaks in the system and seriously affect the accuracy of the system.

7.2 INSTALLATION IN FILL

7.2.1 COMPACTED CLAY

Excavate a trench or recess about twenty inches deep by two to three feet square. Form a cylindrical hole in the sidewall of the trench. The hole diameter should be slightly smaller than the piezometer body.

Push the piezometer into the side of the hole in the host material. If necessary, to ensure continuity with the saturated high air entry filter and the pore water, smear the filter with a thin paste of the saturated material.

Before back filling, the tubing must be laid with the utmost care. Loop the tubing around the recess, making sure it rests on a bed of hand placed and hand compacted screened clay.

Make sure that the tubing does not cross over itself or other tubing in the same area.

Backfill the recess with screened clay containing no particles larger than 3mm in diameter. The backfill should have a water content and density equal to that of the surrounding material.

Make sure that the tubing is protected from potential damage caused by angular material, compacting equipment or stretching due to subsequent deformations during construction or fill placement.

7.2.2 GRANULAR MATERIALS

Install the piezometer in a trench or recess about twenty inches deep by two to three feet square. Place the piezometer within the trench; loop the tubing and backfill with screened material containing the same moisture content and compacted to the same density as the surrounding fill. In rock fill, it is necessary to place a graded filter around the piezometer. Use fine grain clean sand around the instrument and increase the particle size as the backfill proceeds outwards to the rock fill. The sand placed in the recess, around the instrument and tubing should range in size from 0.5 to 3mm in diameter.

7.3 INSTALLATION IN BOREHOLES

The method used to install a piezometer in a borehole depends on the particular conditions in which the installation must be carried out. The method described below will cover most applications. Artesian conditions, borehole stability, available drilling equipment and sealing materials are among the factors that will influence the method chosen.

The drill casing should be driven one foot below the required piezometer elevation. If the piezometer is to measure the pore water pressure in a specific horizon, it will be necessary to drive the casing three feet below the piezometer elevation to enable the placement of a bentonite seal at the bottom of the hole.

After driving the casing the cuttings must be removed. Wash the borehole until the water emerging runs clear.

If required, place a two-foot bentonite seal at the bottom of the borehole. Raise the casing six inches and place the bentonite in six-inch increments until the bentonite level is one foot below the piezometer elevation. Pull the casing as the bentonite is set in place. Be very careful not to plug or allow bentonite to stick to the inside walls of the casing. This is accomplished by making sure the bentonite level is at all times below the casing and by slowly dropping the bentonite chips in single file down the hole. Trying to feed the bentonite chips too rapidly will result in bridging of the chips in the casing or borehole. This will make it extremely difficult to complete the seal. Tamping of compressed bentonite chips is not required.

Prior to setting the sand in place, lower a cylindrical weight down the hole to ensure that the hole is clear from any obstructions and if necessary, rinse the borehole until clear water emerges.

In the same manner, place twelve inches of fine, clean sand in six-inch increments below the level of the piezometer tip. Pull the casing as the sand back-filling proceeds. Lower the piezometer into the hole and take the initial reading as described in section 7.5.

Pull the casing six inches and back fill with fine clean sand. Repeat until the sand and casing is one foot above the top of the piezometer. Then take a reading on the piezometer.

Lift the casing in six-inch increments and backfill with bentonite until a minimum four-foot seal has been formed. During the bentonite placement keep the cable taut to prevent the bentonite from hooking up in the casing. Pour the bentonite in the hole one at a time to avoid bridging.

If more than one piezometer is to be installed in the hole, backfill the casing with either a cement/bentonite grout, host material or sand/bentonite mixture to an elevation of 4 feet below the second piezometer, then use 3 feet of bentonite, 1 foot of sand, then the piezometer. Proceed as described above.

Pull the casing. Use care when pulling the casing so that you do not twist or damage the pneumatic tubing.

Once the entire casing has been removed, top off the borehole with grout.

7.4 FILTER SATURATION

The P-100 Miniature Pneumatic Piezometer requires no pre-saturation of the filter. The P-100-1 Piezometer does not require any elaborate saturation procedures because it has both 50-micron and 70-micron filters which pass both air and water. Only high-air entry filters require elaborate saturation procedures. However, as mentioned above, the recovery of pore water pressure can take some time in a freshly drilled borehole. Readings need to stabilize before it can be assumed that the sampling zone has returned to original conditions. Field-testing has shown that when placed in a borehole, the P-100-1 Casagrande assembly saturates immediately and yields response times identical to the P-100 piezometer. These response times are on the order of seconds, therefore pre-saturation is not an issue.

7.5 INITIAL READING

When installing a piezometer the user must be aware that the act of drilling and backfilling a hole changes the pore-water pressure in the ground. Therefore, the initial readings following the installation will not be representative of the actual conditions. Recovery of the natural pore-water pressure may take some time (hours to weeks) depending on the conditions and the permeability of the soil. When readings have stabilized over the period of a few days, it can be assumed that the sampling zone has returned to original conditions.

8 INSTALLING A P-102-SS PUSH-IN PNEUMATIC PIEZOMETER

This piezometer is designed to handle the rigors of push-in installations.

Caution must be exercised when installing a piezometer using the push-in method. As the piezometer is pushed through the soil, temporary changes in pore water pressure can occur around the piezometer. If these pore water pressures exceed the range of the instrument, permanent can occur. It is recommended that piezometer readings be taken continuously as the instrument is being pushed in, and the rate of pushing be based on the readings. The RST P-102-SS has its filter located on the side of the instrument (Figure 3) which helps avoid over ranging of instrument during installation.

With any push-in installation, it is important that the instrument is in intimate contact with the surrounding soil. Any air space between the filter and the soil can cause erroneous pressure readings. This is of most concern if the piezometer is being installed in an unconsolidated and or unsaturated fill or soil.

8.1 FILTER SATURATION

The P-102-SS piezometer has a removable 70 micron filter that should be pre-saturated prior to installation.

1. Remove the protective bag from the piezometer. Avoid contact with the filter element, for this may effect the performance of the filter.
2. Fill a bucket full of water.
3. Unscrew the drive point of the piezometer, so that water can flow freely into the piezometer (Figure 3).

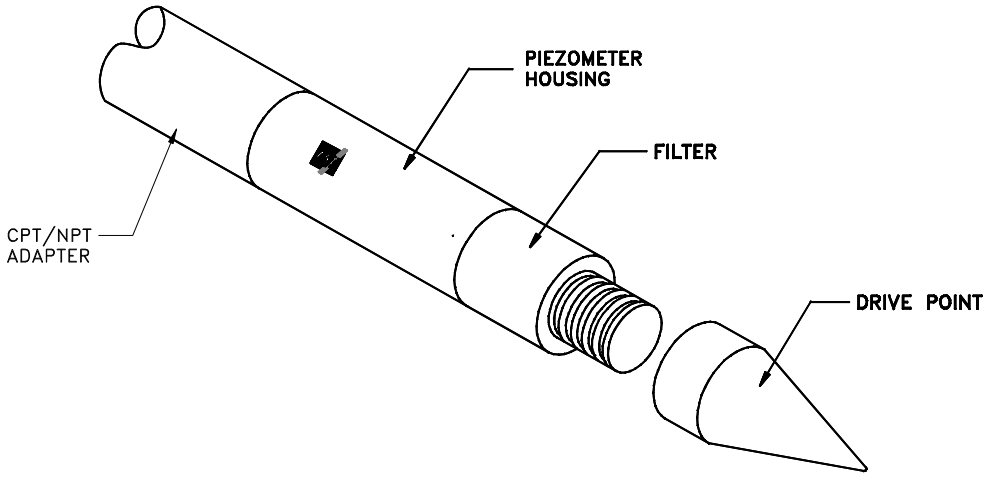

Figure 3 – Unscrew the drive point

4. Immerse the piezometer upside-down in the bucket as shown in Figure 4.
5. Connect the piezometer to the RST Pneumatic Readout.
6. Switch the bypass valve on and off several times.
7. Thread the drive point back on, after the filter has been fully pre-charged and while the piezometer is still immersed in the water. The drive point should be on snug, and the filter slightly compressed in the process.
8. Disconnect the piezometer from the readout and slide the tubing through the adapter pipe.
9. Thread the adapter pipe onto the P-102-SS piezometer.

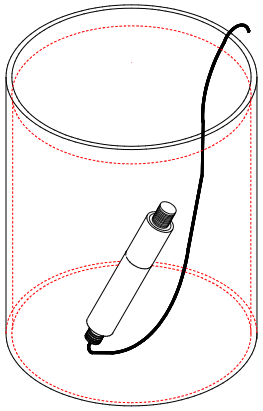

Figure 4 – Immerse in water

8.2 INSTALLATION

Typically, push-in type piezometers are installed in soft soils and clays. The P-102-SS has adapters which can accommodate either NPT or CPT rods. Any installation should be performed under the supervision of a field engineer that has experience with the installation of these types of instruments.

8.3 INITIAL READING

The installation of a piezometer often disturbs the surrounding ground water conditions. Therefore, the initial readings following the installation will not be representative of the actual conditions. Recovery of the natural pore-water pressure may take some time (hours to weeks) depending on the conditions and the permeability of the soil. When readings have stabilized over the period of a few days, it can be assumed that the sampling zone has returned to its original conditions.

9 TAKING READINGS

Please refer to the *RST Pneumatic Readout Instrument Instruction Manual* for a complete description on how to take readings with the P-100-1 Piezometer.

10 SPLICING PNEUMATIC TUBING

10.1 SPLICE KIT

The RST A-104 Splice Kit contains the necessary materials to join two lengths of twin pneumatic tubing.

10.2 INSTRUCTIONS

It is imperative that dirt does not enter the pneumatic lines during the splicing process. This cannot be over-emphasized, as the introduction of dirt into the factory sealing system can seriously affect the performance of the system.

In the event that a break is being repaired in the field, it is necessary to cut a few feet back on each side of the break to avoid the inclusion of dirt.

1. Cut the PVC jacket back 2½ - 2¾ inches in order to expose the black and white pneumatic tubes. Check that there is not damage to the tubing in the form of nicks or cuts.

2. Lay out the tubing and cut the individual tubes so that the unions will be staggered when the tubes are joined (Figure 5). Make sure to cut the tubes as square as possible.

3. Using ONLY the brass compression fittings provided, join the pneumatic lines maintaining the black to black, white to white, colour coding (see Figure 5). **Never re-use any old compression fittings.** Insure that the tubing has bottomed in the fitting. Finger tighten the compression nuts, and then apply 1 full turn with a wrench. **Do not over tighten!**

4. Snap the mold body around the completed splice and install the pouring spouts (Figure 5).

5. Using the tape provided, seal any gaps between the plastic mold and the jacket. Stretch the tape up to 50 percent of its length when applying. Try to cover up at least 2 inches beyond the ends of the molding tube.

6. Mix epoxy as per the instructions on the pouch, and pour into one spout until the mold is full and the epoxy begins to rise in the other spout.

7. The completed splice must allow the epoxy to bond to the jacket, as well as the plastic tubes. Pressurize the tubes, and check for leaks.

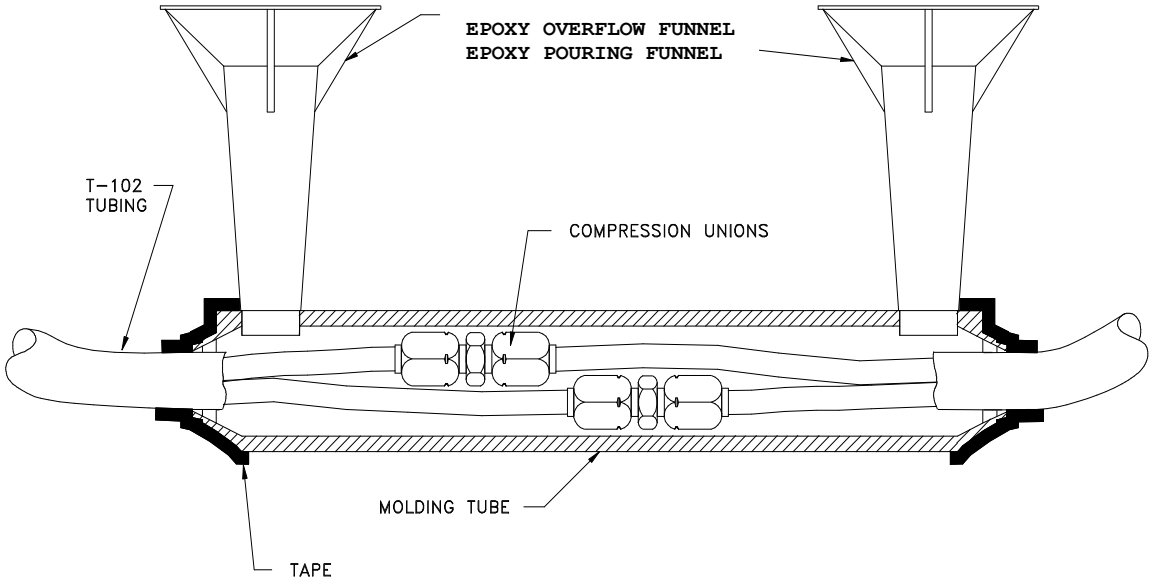

Figure 5 – Splicing Pneumatic Tubing

11 SHORTENING/EXTENDING THE TUBING

1. Cut the male quick connect off the black tube
2. Cut tubing to design length.
3. Peel the PVC jacket back a few inches (score with an Exacto knife), taking care not to cut the pneumatic lines.
4. Using the compression fitting provided, re-attach the quick connect to the black line. Tighten 1 turn past finger tight with a wrench (be careful not to over-tighten).

RST recommends that only the compression fittings supplied with the splice kit be used. The use of other brands with fittings not specifically designed for plastic tube may misalign during installation, causing leakage. **Never re-use old compression fittings!**

The male quick connect fitting supplied with the piezometer has an integral 50 micron filter. The use of non-filtered types is not recommended as this will permit the ingress of dirt, and may cause failure.

We recommend that the piezometer be read before and after splicing to insure proper operation, and provide an indication of any possible calibration offset caused by the addition of extra tubing. This offset, caused by friction head loss in the pneumatic lines should not be a factor, unless a considerable length of tubing is added.