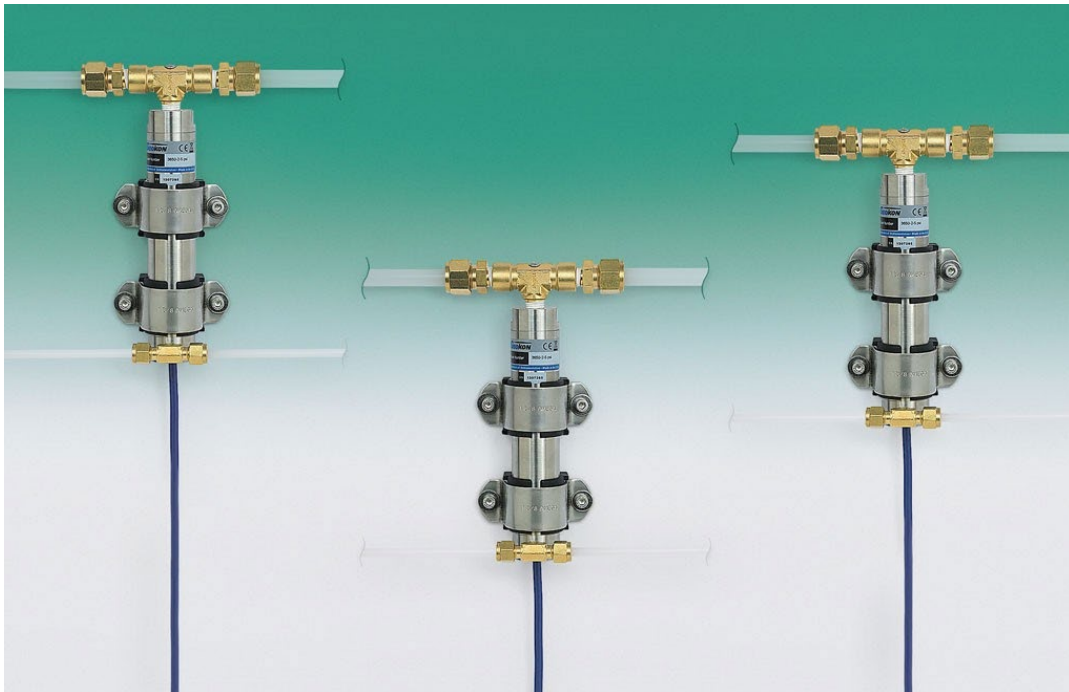


*Instruction Manual*  
**Model 3655**  
**Multipoint Settlement System**



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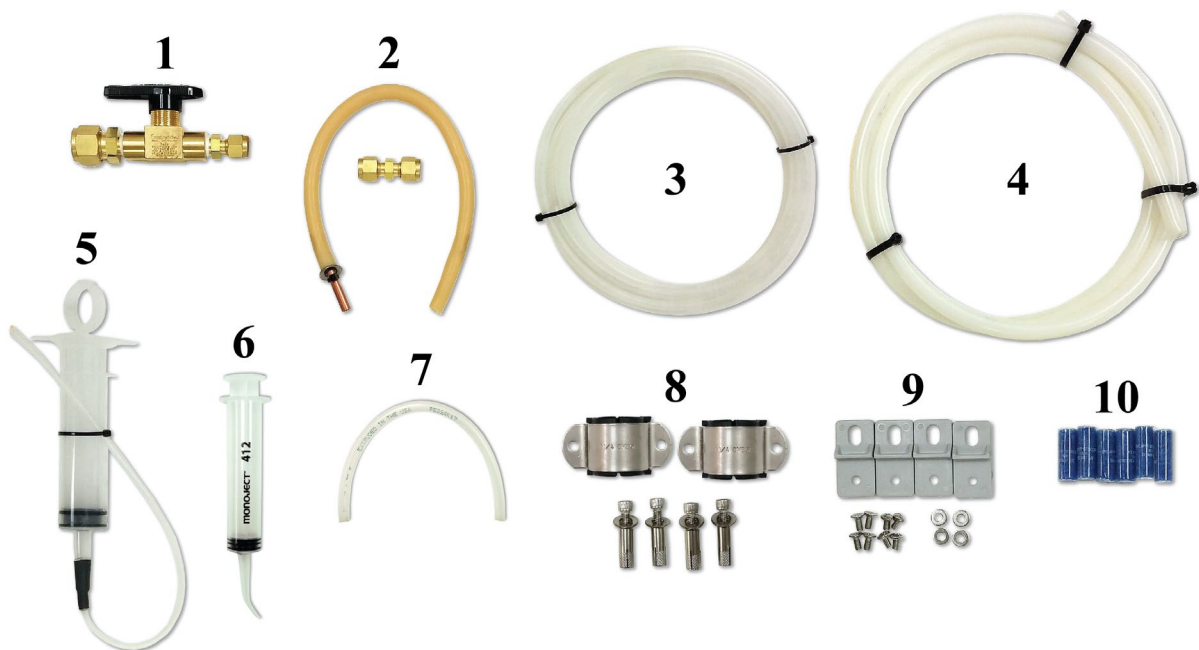
## **1. THEORY OF OPERATION**

The Model 3655 Settlement System is a multipoint settlement system, comprising a series of sensitive pressure transducers connected together by a nylon, liquid-filled tube, which in turn, is connected to a liquid reservoir. The reservoir has a large liquid capacity as compared to the volume required to fill the system, which helps to minimize the effects caused by small changes in tubing volume over varying temperatures.

In use, any change in elevation of a sensor will result in a change in the height of the liquid column between reservoir and sensor and in the pressure measured by that sensor. Since all the sensors share the same liquid line, and are referenced to the same liquid elevation in the reservoir, changes in the sensor elevations, relative to one another, can be measured.

## **2. INSTALLATION**

### **2.1 Provided Accessories**



**Figure 1 - 3655 Accessories**

The items shown in Figure 1 are as follows:

1. Bi-directional valve
2. Rubber tubing and union for vacuum pump attachment
3. 1/4" polyethylene, vent line tubing
4. 1/2" nylon, liquid line tubing
5. Syringe for making small adjusting in the level of fluid in the reservoir through the Swagelok in the cap
6. Syringe for extracting air or liquid from the sensor through the seal screw hole
7. Jumper line for connecting the settlement system liquid reservoir to the desiccant chamber
8. Sensor mounting brackets and supplied hardware
9. Reservoir enclosure mounting feet and supplied hardware
10. Spare desiccant packs

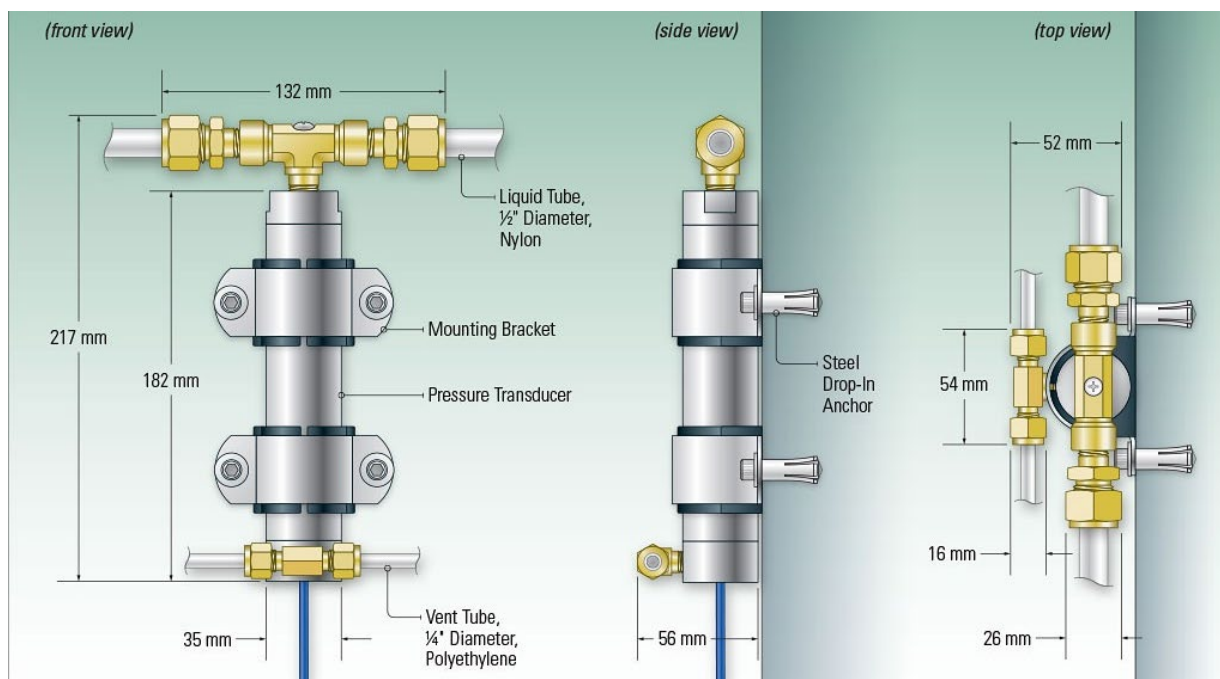
## 2.2 Installing the Reservoir and Sensors

The first step is to determine the elevation of all the sensors and the reservoir. Remember that the reservoir should be above every sensor and that the difference in elevation between the reservoir and any sensor should be within the full-scale range of the pressure transducers. The Reservoir should be attached to a stable structure or one that can easily be level surveyed to.

The sensors are installed by attaching the supplied brackets to the concrete or other surface using either the supplied drop-in style anchor, or bolts/studs that are welded to or screwed into the steel or other material as shown in Figure 2.

### 2.2.1 Mounting Sensors to Cement with the Provided Drop-in Anchors

- 1) Use a leveling device to align the first mounting bracket vertically on the wall. Mark the locations where the two anchors will be installed.
- 2) Using a masonry drill (or other suitable equipment), drill two half inch (12 mm) holes approximately 1.5" (37 mm) deep. Clean the holes thoroughly, blowing out with compressed air if possible.
- 3) Insert the expansion anchors into the holes. (The threaded end should be closest to the opening.)
- 4) Insert the provided setting tool, small end first, into an anchor. Expand the anchor by hitting the large end of the setting tool with several sharp hammer blows. Repeat for the second anchor.
- 5) Repeat steps one through four for the second mounting bracket.
- 6) Attach the sensor to the wall using the mounting brackets and supplied hardware, as illustrated in Figure 2.



**Figure 2 - Model 3655 Mounting Details**



## 2.3 Installing the Tubing

The tubing should be installed after the sensors and reservoir have been fixed in position. It is recommended that the tubing be shielded from direct sunlight as fluctuating temperatures can change the specific gravity of the fluid, which can be difficult to correct for.

Tee connectors are supplied for both the liquid and air lines and the reservoirs are delivered with both tubing connectors and caps, depending on whether or not the system is a series or “branch” system, or a combination of the two.

### 2.3.1 Liquid Line

Only nylon tubing should be used for the liquid line because it is the best material for keeping air out of the system thereby preventing the formation of bubbles in the liquid lines (which would adversely affect the readings). The liquid tubing runs should be as straight as possible, ideally within an elevation of  $\pm 9.5$  mm (0.375"), without rises and dips. (Some minor dips in the line are allowable if using a vacuum to fill.) Siphons must be avoided at all cost. The minimum recommended bend radius for the liquid tubing is 31.8 mm (1.25").

### 2.3.2 Vent Line

The routing of the vent line is much less critical than the liquid line. It may be run along any path, so long as it is installed below the liquid line. (As shown in Figure 3.) One end of the vent line is capped off at the tee fitting of the most remote sensor, while the other end terminates at a desiccant chamber located next to the reservoir as shown in Figure 3.

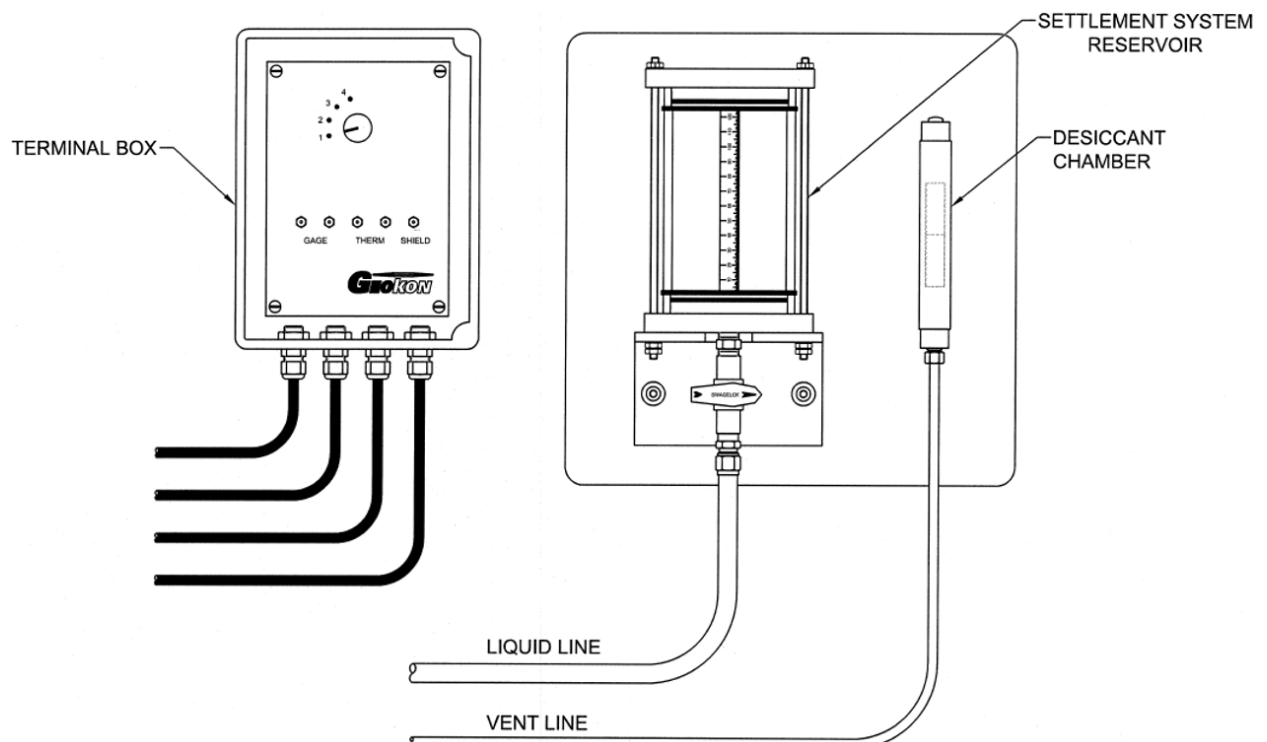


Figure 3 - Model 3655-1 Reservoir, Desiccant Chamber and Terminal Box

### 2.3.3 Jumper Line

The provided jumper line may be utilized to connect the settlement system liquid reservoir to the desiccant chamber. Depending on site conditions, adding or removing the jumper may help to stabilize the sensor readings.



**Figure 4 - Liquid Reservoir and Desiccant Chamber connected with Jumper**

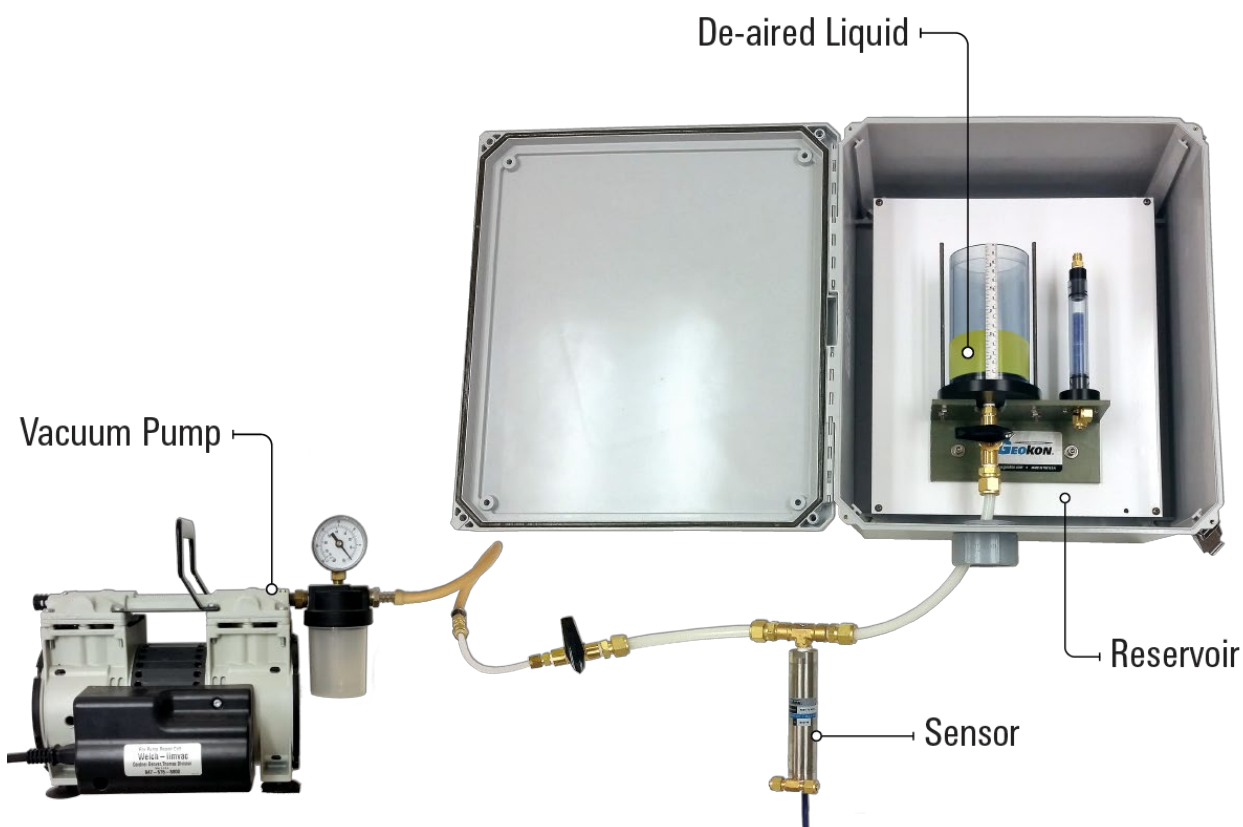
### **3. FILLING THE SYSTEM**

Eliminating air from the system is very important. The use of de-aired fluid is required and this can be purchased from Geokon. The liquid used in the system must be one of a known specific gravity to convert the sensor gauge factor, which is presented in kPa/mA to mm/mA. The conversion from kPa to mm of distilled water is:  $1 \text{ kPa} = 102.2 \text{ mm of water}$ . If a mixture of distilled water and antifreeze, such as ethylene glycol, or propylene glycol, is used, the specific gravity of the fluid must be measured, and the gauge factor adjusted accordingly by dividing the 102.2 number by the specific gravity. If only distilled water or propylene glycol is used, a very small amount of ethylene glycol antifreeze, (5% by volume), or a couple of crystals of copper sulfate must be added to prevent the growth of algae. The fluid supplied by Geokon is a 50/50 mix of propylene glycol and water with an algae suppressant added.

Filling the system is the most difficult job due to the problems associated with entrapped air bubbles and the need to remove them. Two people will be needed for this process, one to tend to the reservoir and vacuum pump and one to monitor the fluid as it enters the system. An electric vacuum pump is essential if bubbles are to be avoided. (Vacuum pumps may be purchased from Geokon.) Without a vacuum pump bubbles will form in the tubing and will need to be 'chased' out.

The systems can be filled from the reservoir or from the far end of the tubing, as described in Sections 3.1 and 3.2.

#### **3.1 Filling from the Reservoir**



**Figure 5 - Filling from the Reservoir**

First, attach a length of half inch tubing (three feet has been provided) to the last sensor in the string furthest from the reservoir. To that piece of tubing, swage on the bidirectional valve provided. (See Appendix C for Swagelok instructions.) Next, a length of 6.4 mm (1/4") tubing, long enough to reach the vacuum pump, can be cut from the 3 meter (10 ft.) piece provided and attached to the opposing side of the valve. A piece of rubber tube and a union have been included which may aid in the connection of the pump.

Close the valve on the bottom of the reservoir then fill the reservoir with de-aired liquid. Open the valve nearest to the vacuum pump and turn the pump on to start evacuating the system. A general recommendation for the vacuum pressure level is below 10 Mbar when filling the settlement systems, but this may not be possible depending on how large the system is as a whole and the strength of the pump that is being used. The lower pressure the better, in order to build confidence that there aren't any leaks in the connectors.

When the vacuum has been established, fill the reservoir with de-aired liquid and then open the valve at the base of the reservoir and allow the de-aired liquid to flow and fill the lines up to each sensor. Be sure to add de-aired liquid to the reservoir as it is draining into the system to prevent air from contaminating the tubing. Take notice of the liquid as it nears the vacuum pump and close the valve closest to it before the liquid is drawn in, which can damage the pump. With the valve closed, the vacuum pump can be turned off.

A small amount of air may be entrapped inside each sensor, which must be bled off by removing the seal screw on the top of the tee fitting from each sensor in turn (Figure 6) and by extracting air or liquid from the sensor through the seal screw hole using the syringe supplied (Figure 7). When all of the air has been removed from all sensors, replace the seals crews. If a bubble is observed in the liquid line, 'chase' the bubble back to the reservoir, or to one of the sensors fittings, where it can be allowed to escape by slightly opening the connector at this point and/or opening the seal screw on the tee. Adjust the level of fluid in the reservoir with the supplied syringe to approximately midway.

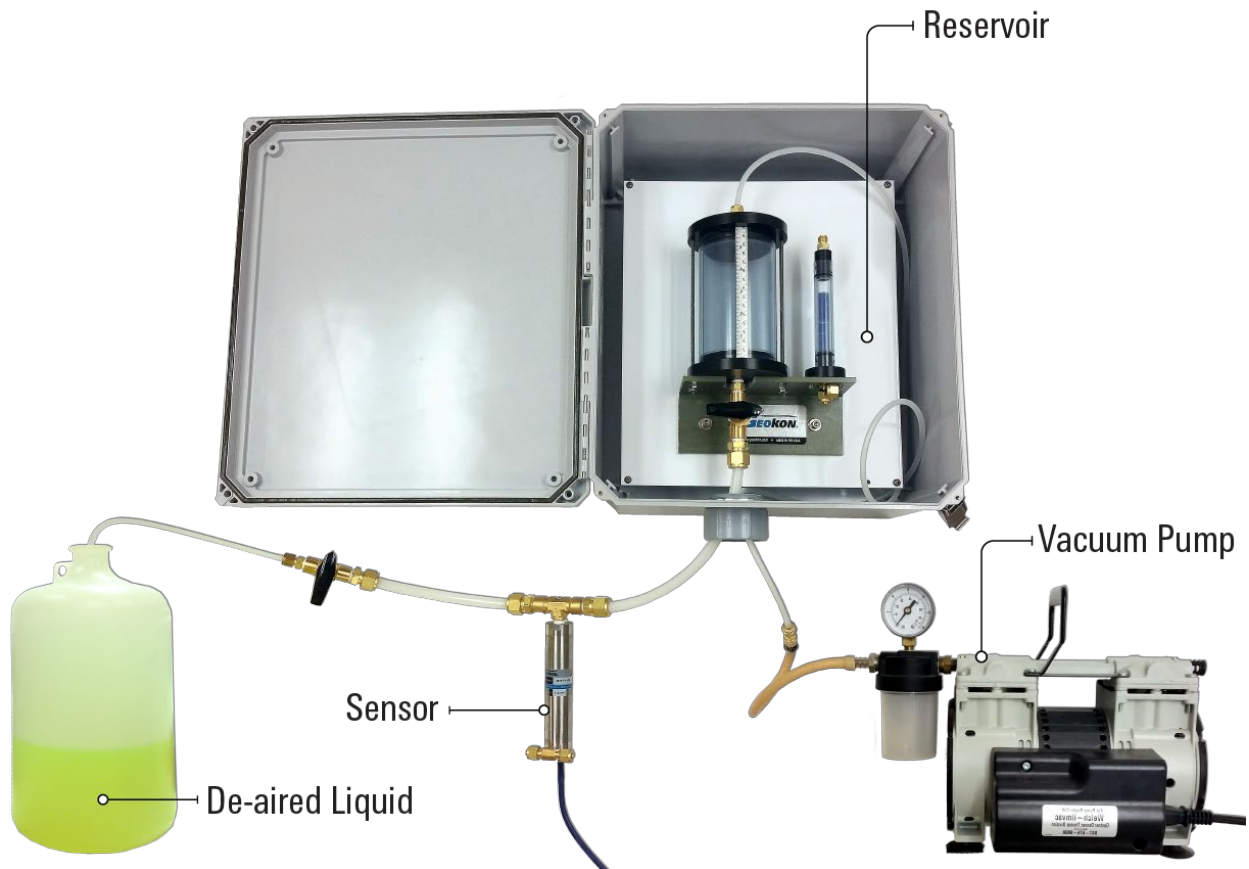


**Figure 6 - Seal Screw Removal**



**Figure 7 - Using Syringe for Air/Liquid Extraction**

### 3.2 Filling from the far end of the Tubing



**Figure 8 - Filling from the far end**

First, attach a length of half inch tubing (three feet has been provided) to the last sensor in the string. To that piece of tubing, swage on the bidirectional valve provided. (See Appendix C for Swagelok instructions.) Next, a length of 6.4 mm (1/4") tubing, long enough to reach the vessel containing the settlement fluid, can be cut from the 3 meter (10 ft.) piece provided and attached to the opposing side of the valve. Insert the free end of the tube into the fluid and close the valve.

At the reservoir end, swage to the top of the reservoir a length of the 6.4 mm (1/4") tubing, long enough to reach the vacuum pump. Attach the free end to the vacuum pump and apply a vacuum to the system with the reservoir valve open. A piece of rubber tube and a union have been included which may aid in the connection of the pump. A general recommendation for the vacuum pressure level is below 10 Mbar when filling the settlement systems, but this may not be possible depending on how large the system is as a whole and the strength of the pump that is being used. The lower pressure the better, in order to build confidence that there aren't any leaks in the connectors.

When a vacuum has been established, open the valve on the far end of the system to allow de-aired fluid to flow through. To prevent bubbles in the system it is recommended to combine all the fluid into one large container or leave the fill line in one vessel and continue to add fluid into it, making sure the liquid level never falls below the end of the fill tube where air can then be introduced into the system. Once fluid has filled the entire system and has entered the reservoir, disconnect the vacuum pump and close the valve on the far end. Remove the 6.4 mm (1/4") vacuum pump extension tube from the reservoir.

A small amount of air may be entrapped inside each sensor, which must be bled off by removing the seal screw on the top of the tee fitting from each sensor in turn (Figure 9) and by extracting air or liquid from the sensor through the seal screw hole using the syringe supplied (Figure 10). When all of the air has been removed from all sensors, replace the seals crews. If a bubble is observed in the liquid line, 'chase' the bubble back to the reservoir, or to one of the sensors fittings, where it can be allowed to escape by slightly opening the connector at this point and/or opening the seal screw on the tee. Adjust the level of fluid in the reservoir with the supplied syringe to approximately midway.



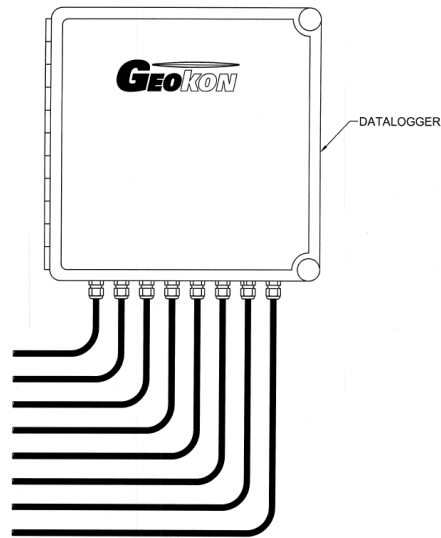
**Figure 9 - Seal Screw Removal**



**Figure 10 - Using Syringe for Air/Liquid Extraction**

## **4. ROUTING THE CABLES**

Cables from each sensor can be routed to the readout location where they can be connected to a terminal box (as shown in Figure 3) for manual readout, or to datalogger as shown in Figure 11.



**Figure 11 - Datalogger**

## **5. TAKING READINGS**

There are three different types of sensor available:

Model 3655 -1 which has 0 to 100 mV DC output, requiring a regulated 10 Volt supply

Model 3655-2 which has 0 to 5 Volts DC output, requiring a 7 to 35 Volt DC supply

Model 3655-3 which has 4 to 20 mA output, requiring a 7 to 35 Volt DC supply.

In addition, a multimeter is required that can read millivolts, volts or milliamps to three decimal places. Wiring Charts are shown in Appendix A.

All sensors are supplied with calibration reports showing the gauge factor in the appropriate units of kPa /mV or kPa/Volt or kPa/mA. Typical calibration reports are shown in Appendix C.

Each gauge factor is then converted to mm/mV or mm/V or mm/mA so that the readings (R), can be converted into the height of the fluid column between reservoir and sensor.

After the system is installed and filled the sensor system zero reading ( $R_0$ ) should be taken. It is good practice to take several zero readings over the period of a day to get an idea how much the readings will fluctuate during the normal course of a day when no actual work is taking place at the site. (This data can be useful in computing a correction factor for temperature variations)

Subsequent readings ( $R_1$ ) on the system will yield the change in elevation of the sensors along the string relative to the elevation of the reservoir and to each other.



## **6. DATA REDUCTION**

### **6.1 Calculation of Sensor Elevation**

Readings can be used to calculate the elevations of each sensor and to plot them on a graph versus time. For all types of sensors, the readings will get larger as the sensors settle relative to the reservoir.

For all sensors the elevation (E) of the sensor is given by:

$$E = E_0 - (R_1 - R_0) G \times 0.1022 + \Delta E_{\text{RES}}$$

**Equation 1 - Elevation**

Where;

$E_0$  is the sensor elevation at installation in meters

$\Delta E_{\text{RES}}$  is any change of the fluid level inside the reservoir. If the fluid level falls,  $\Delta E_{\text{RES}}$  is negative. If the fluid level rises,  $\Delta E_{\text{RES}}$  is positive.

$R_0$  is the initial sensor reading in mA

$R_1$  is the subsequent sensor reading in mA

G is the calibration factor supplied with the sensor in kPa/mV, kPa/Volt, or kPa/mA.

0.1022 is the conversion factor which converts kPa into meters of pure water

#### **Example for Model 3655-1 type sensors:**

If;

$E_0 = 541.62$  meters

$R_0 = 10.400$  mA

$R_1 = 13.601$  mA

$G = 2.507$  kPa/mA

$\Delta E_{\text{RES}} = -10$  mm (i.e. the level of water in the reservoir sight tube is 10 mm lower than the level measured at the time of the initial reading).

Then new sensor elevation is:

$E = 541.62 - (13.601 - 10.400) \times 2.507 \times 0.1022 + (-0.010)$

$E = 540.8$  meters

In other words, there has been a settlement of 0.82 meters at this sensor relative to the reservoir location.

### **6.2 Correction for Settlement or Heave of the Reservoir Terminal**

Periodic level surveys should be made of the elevation of the fixture on which the reservoir terminal is located. Any measured settlement of the reservoir should be subtracted from the calculated sensor elevations.

### 6.3 Corrections for Temperature

Temperature effects on liquid volume (liquid density) and on the expansion and contraction of the liquid confines can be quite complex and in some ways self-canceling. Liquid lines in fills are generally well insulated; therefore, temperature effects tend to be insignificant. Systems exposed to the atmosphere and to sunlight can suffer from rapidly changing temperatures at different parts of the system causing significant fluctuation of the readings. In such cases precautions may be necessary to obtain readings at times of maximum temperature stability. Temperature effects on the sensor can be corrected for but are usually quite insignificant especially if the sensor is buried.

The temperature correction to the elevation ( $E_T$ ) is given by:

$$E = E_0 - [(R_1 - R_0) G \times 0.1022 + (T_1 - T_0) K] - \Delta E_{RES}$$

#### Equation 2 - Temperature Correction

Where;

$T_0$  is the initial temperature

$T_1$  is the current temperature, in °C

$K$  is the temperature correction factor in meters/°C. This factor can be determined empirically by measuring the temperature as well as the sensor outputs at times when no settlement is taking place and then calculating the slope of the line from a plot of temperature v mA.

## **APPENDIX A. WIRING CHARTS**

### **A.1 Model 3500-1, mV/V Output**

<b>Geokon Cable #04-375V9 (Violet)</b>	<b>Internal Sensor Wiring</b>	<b>Function / Description</b>
Red	Red	Power +
Red's Black	Black	Power -
White	White	Signal +
White's Black	Black	Signal -
Green	Red	Remote Sense +
Green's Black	Black	Remote Sense -
Blue	N/C	Thermistor
Blue's Black	N/C	Thermistor
Shields (5)	N/C	Ground

**Table 1 - Wiring Chart for Model 3500-1**

**Note:** Input voltage for Model # 3500-1, mV/V output is 10V d.c. (Power -, Signal -, Remote Sense -, are connected internally.)

### **A.2 Model 3500-2, 0–5VDC Output**

<b>Geokon Cable #04-375V9 (Violet)</b>	<b>Internal Sensor Wiring</b>	<b>Function / Description</b>
Red	Red	Power +
Red's Black	Black	Power -
White	White	Signal +
White's Black	Black	Signal -
Blue	N/C	Thermistor
Blue's Black	N/C	Thermistor
Shields (5)	N/C	Ground

**Table 2 - Wiring Chart for Model 3500-2**

**Note:** Input voltage for Model # 3500-2, 0–5VDC output is 6.5–35V d.c.

### **A.3 Model 3500-3, 4–20mA Output**

<b>Geokon Cable #02-250V6 (Blue)</b>	<b>Internal Sensor Wiring</b>	<b>Function / Description</b>
Red	Red	Power +
Black	Black	Power -
White	N/C	Thermistor
Green	N/C	Thermistor
Shields (1)	N/C	Ground

**Table 3 - Wiring Chart for Model 3500-3**

**Note:** Input voltage for Model # 3500-3, 4–20mA output is 6.5–35V d.c.

## APPENDIX B. THERMISTOR TEMPERATURE DERIVATION

Thermistor Type: YSI 44005, Dale #1C3001-B3, Alpha #13A3001-B3

Resistance to Temperature Equation:

$$T = \frac{1}{A + B(\ln R) + C(\ln R)^3} - 273.15 \text{ } ^\circ\text{C}$$

Equation 3 - Resistance to Temperature

Where;

T = Temperature in  $^{\circ}\text{C}$ .

$\ln R$  = Natural Log of Thermistor Resistance

$A = 1.4051 \times 10^{-3}$

$B = 2.369 \times 10^{-4}$


$C = 1.019 \times 10^{-7}$

Note: Coefficients calculated over the  $-50$  to  $+150^{\circ}\text{C}$ . span.

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
201.1K	-50	16.60K	-10	2417	+30	525.4	+70	153.2	+110
187.3K	-49	15.72K	-9	2317	31	507.8	71	149.0	111
174.5K	-48	14.90K	-8	2221	32	490.9	72	145.0	112
162.7K	-47	14.12K	-7	2130	33	474.7	73	141.1	113
151.7K	-46	13.39K	-6	2042	34	459.0	74	137.2	114
141.6K	-45	12.70K	-5	1959	35	444.0	75	133.6	115
132.2K	-44	12.05K	-4	1880	36	429.5	76	130.0	116
123.5K	-43	11.44K	-3	1805	37	415.6	77	126.5	117
115.4K	-42	10.86K	-2	1733	38	402.2	78	123.2	118
107.9K	-41	10.31K	-1	1664	39	389.3	79	119.9	119
101.0K	-40	9796	0	1598	40	376.9	80	116.8	120
94.48K	-39	9310	+1	1535	41	364.9	81	113.8	121
88.46K	-38	8851	2	1475	42	353.4	82	110.8	122
82.87K	-37	8417	3	1418	43	342.2	83	107.9	123
77.66K	-36	8006	4	1363	44	331.5	84	105.2	124
72.81K	-35	7618	5	1310	45	321.2	85	102.5	125
68.30K	-34	7252	6	1260	46	311.3	86	99.9	126
64.09K	-33	6905	7	1212	47	301.7	87	97.3	127
60.17K	-32	6576	8	1167	48	292.4	88	94.9	128
56.51K	-31	6265	9	1123	49	283.5	89	92.5	129
53.10K	-30	5971	10	1081	50	274.9	90	90.2	130
49.91K	-29	5692	11	1040	51	266.6	91	87.9	131
46.94K	-28	5427	12	1002	52	258.6	92	85.7	132
44.16K	-27	5177	13	965.0	53	250.9	93	83.6	133
41.56K	-26	4939	14	929.6	54	243.4	94	81.6	134
39.13K	-25	4714	15	895.8	55	236.2	95	79.6	135
36.86K	-24	4500	16	863.3	56	229.3	96	77.6	136
34.73K	-23	4297	17	832.2	57	222.6	97	75.8	137
32.74K	-22	4105	18	802.3	58	216.1	98	73.9	138
30.87K	-21	3922	19	773.7	59	209.8	99	72.2	139
29.13K	-20	3748	20	746.3	60	203.8	100	70.4	140
27.49K	-19	3583	21	719.9	61	197.9	101	68.8	141
25.95K	-18	3426	22	694.7	62	192.2	102	67.1	142
24.51K	-17	3277	23	670.4	63	186.8	103	65.5	143
23.16K	-16	3135	24	647.1	64	181.5	104	64.0	144
21.89K	-15	<b>3000</b>	<b>25</b>	624.7	65	176.4	105	62.5	145
20.70K	-14	2872	26	603.3	66	171.4	106	61.1	146
19.58K	-13	2750	27	582.6	67	166.7	107	59.6	147
18.52K	-12	2633	28	562.8	68	162.0	108	58.3	148
17.53K	-11	2523	29	543.7	69	157.6	109	56.8	149
								55.6	150

Table 4 - Thermistor Resistance Versus Temperature

## APPENDIX C. TYPICAL CALIBRATION REPORTS

		48 Spencer St. Lebanon, N.H. 03766 USA	
<h3>Pressure Transducer Calibration Report</h3>			
Model Number: <u>3655-1-250 kPa</u>		Date of Calibration: <u>March 14, 2014</u>	
Serial Number: <u>1403654</u>		Temperature: <u>20.8 °C</u>	
Pressure Range: <u>250 kPa</u>		Barometric Pressure: <u>997 mbar</u>	
Calibration Instruction: <u>CI-VW Pressure Transducers</u>			
Technician: _____			

Applied Pressure (kPa)	Gage Reading (mV) 1st Cycle	Gage Reading (mV) 2nd Cycle	Average Gage Reading	Change	Linearity (%FS)	Polynomial Fit (%FS)
0	-0.100	-0.099	-0.100		0.07	0.00
50	19.924	19.926	19.925	20.02	0.01	0.00
100	39.923	39.921	39.922	20.00	0.06	0.00
150	59.870	59.850	59.860	19.94	0.05	0.00
200	79.780	79.770	79.775	19.92	0.02	0.01
250	99.630	99.630	99.630	19.86	0.07	0.00

Linear Gage Factor (G): <u>2.507</u> (kPa / mV)		Regression Zero: <u>-0.031</u>	
Polynomial Gage Factors: A: <u>1.32E-04</u>		B: <u>2.4935</u> C: <u>0.2531</u>	

<b>Calculated Pressures:</b> <b>Linear, <math>P = G(R_1 - R_0) \times 10 / V_1</math></b>	
<b>Polynomial, <math>P = AR_p^2 + BR_p + C</math>    <math>[R_p = R_1 \times 10 / V_1]</math></b>	

Input Voltage, $V_1$ : <u>10</u> VDC
--------------------------------------

Wiring Code:    See manual for further information.
---

The above instrument was found to be In Tolerance in all operating ranges. The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1. This report shall not be reproduced except in full without written permission of Geokon Inc.
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Figure 12 - Typical Calibration Report for Model 3655-1



48 Spencer St. Lebanon, N.H. 03766 USA

## Pressure Transducer Calibration Report

Model Number: 3655-2-400 kPaDate of Calibration: March 28, 2014Serial Number: 1408615Temperature: 22.7 °CPressure Range: 400 kPaBarometric Pressure: 991.1 mbarCalibration Instruction: CI-VW Pressure Transducers

Technician: \_\_\_\_\_

Applied Pressure (kPa)	Gage Reading (Volts) 1st Cycle	Gage Reading (Volts) 2nd Cycle	Average Gage Reading	Change	Linearity (%FS)	Polynomial Fit (%FS)
0	-0.060	-0.060	-0.060		0.05	0.00
80	0.943	0.943	0.943	1.00	0.01	0.00
160	1.945	1.945	1.945	1.00	0.05	0.01
240	2.944	2.944	2.944	1.00	0.03	-0.01
320	3.944	3.943	3.944	1.00	0.03	0.01
400	4.940	4.938	4.939	1.00	0.06	-0.01

Linear Gage Factor (G): 80.01 (kPa / Volt)      Regression Zero: -0.0573

Polynomial Gage Factors: A: 6.79E-02      B: 79.68      C: 4.788

Calculated Pressures: Linear,  $P = G(R_1 - R_0)$

Polynomial,  $P = AR_1^2 + BR_1 + C$

Factory Zero Reading: Input Voltage: 24 VDC

Wiring Code: See manual for further information.

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.  
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**Figure 13 - Typical Calibration Report for Model 3655-2**



48 Spencer St. Lebanon, N.H. 03766 USA

## Pressure Transducer Calibration Report

Model Number: 3655-3-35 kPa Date of Calibration: March 29, 2014

Serial Number: 1307286 Temperature: 22.5 °C

Pressure Range: 35 kPa †Barometric Pressure: 996.1 mbar

Calibration Instruction: CI-VW Pressure Transducers

Technician: \_\_\_\_\_

Applied Pressure (kPa)	Gage Reading (mA) 1st Cycle	Gage Reading (mA) 2nd Cycle	Average Gage Reading	Change	Linearity (%FS)	Polynomial Fit (%FS)
0	3.998	3.998	3.998		-0.03	-0.02
7	7.210	7.211	7.211	3.21	0.05	0.05
14	10.399	10.398	10.399	3.19	-0.02	-0.03
21	13.602	13.599	13.601	3.20	0.00	-0.01
28	16.803	16.801	16.802	3.20	0.01	0.01
35	19.999	19.999	19.999	3.20	-0.01	0.00

Linear Gage Factor (G): 2.188 (kPa/ mA) Regression Zero: 4.003

Polynomial Gage Factors: A: 9.02E-05 B: 2.186 C:\* -8.75

Calculated Pressures: Linear,  $P = G(R_i - R_0)$

Polynomial,  $P = AR_i^2 + BR_i + C$

Input Voltage: 24 VDC

Wiring Code: See manual for further information.

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

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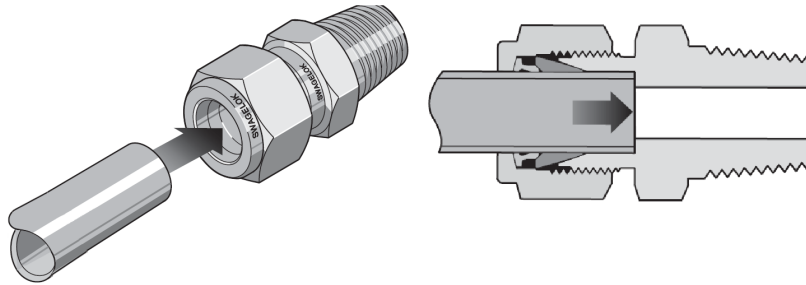
Figure 14 - Typical Calibration Report for Model 3655 -3

## **APPENDIX D. SWAGELOK TUBE FITTING INSTRUCTIONS**

These instructions apply to one inch (25 mm) and smaller fittings.

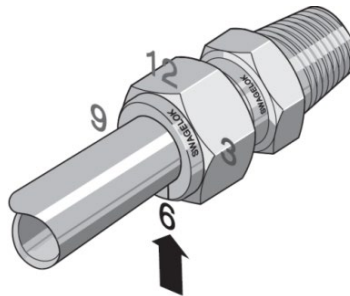
### **D.1 Installation**

- 1) Fully insert the tube into the fitting until it bumps against the shoulder.



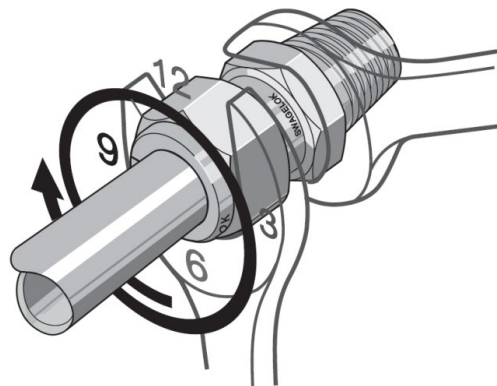
**Figure 15 - Tube Insertion**

- 2) Rotate the nut until it is finger-tight. (For high-pressure applications as well as high-safety-factor systems, further tighten the nut until the tube will not turn by hand or move axially in the fitting.)
- 3) Mark the nut at the six o'clock position.



**Figure 16 - Make a Mark at Six O'clock**

- 4) While holding the fitting body steady, tighten the nut one and one-quarter turns until the mark is at the nine o'clock position. (Note: For 1/16", 1/8", 3/16", and 2, 3, and 4 mm fittings, tighten the nut three-quarters of a turn until the mark is at the three o'clock position.)



**Figure 17 - Tighten One and One-Quarter Turns**



## D.2 Reassembly Instructions

Swagelok tube fittings can be disassembled and reassembled many times.

**Warning! Always depressurize the system before disassembling a Swagelok tube fitting.**

- 1) Prior to disassembly, mark the tube at the back of the nut, then make a line along the nut and fitting body flats. *These marks will be used during reassembly to ensure the nut is returned to its current position.*

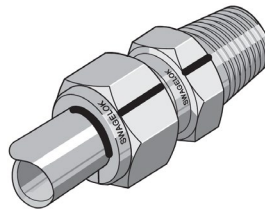


Figure 18 - Marks for Reassembly

- 2) Disassemble the fitting.
- 3) Inspect the ferrules for damage and replace if necessary. **If the ferrules are replaced the connector should be treated as a new assembly. Refer to the section above for installation instructions.**
- 4) Reassemble the fitting by inserting the tube with preswaged ferrules into the fitting until the front ferrule seats against the fitting body.

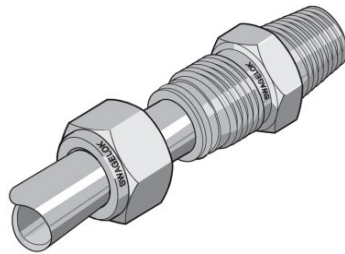


Figure 19 - Ferrules Seated Against Fitting Body

- 5) While holding the fitting body steady, rotate the nut with a wrench to the previous position as indicated by the marks on the tube and the connector. At this point, there will be a significant increase in resistance.
- 6) Tighten the nut slightly.

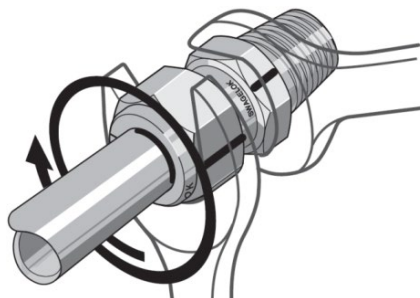


Figure 20 - Tighten Nut Slightly