GEOKON
The World Leader in Vibrating Wire Technology

48 Spencer Street
Lebanon, NH 03766, USA
Tel: 603•448•1562
Fax: 603•448•3216
E-mail: geokon@geokon.com
http://www.geokon.com

Instruction Manual

Model 4615

Hydraulic Overflow Settlement System

(Rev A, 06/05/2018)

Warranty Statement

Geokon, Inc. warrants its products to be free of defects in materials and workmanship, under normal use and service for a period of 13 months from date of purchase. If the unit should malfunction, it must be returned to the factory for evaluation, freight prepaid. Upon examination by Geokon, if the unit is found to be defective, it will be repaired or replaced at no charge. However, the WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion or current, heat, moisture or vibration, improper specification, misapplication, misuse or other operating conditions outside of Geokon's control. Components which wear or which are damaged by misuse are not warranted. This includes fuses and batteries.

Geokon manufactures scientific instruments whose misuse is potentially dangerous. The instruments are intended to be installed and used only by qualified personnel. There are no warranties except as stated herein. There are no other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and of fitness for a particular purpose. Geokon, Inc. is not responsible for any damages or losses caused to other equipment, whether direct, indirect, incidental, special or consequential which the purchaser may experience as a result of the installation or use of the product. The buyer's sole remedy for any breach of this agreement by Geokon, Inc. or any breach of any warranty by Geokon, Inc. shall not exceed the purchase price paid by the purchaser to Geokon, Inc. for the unit or units, or equipment directly affected by such breach. Under no circumstances will Geokon reimburse the claimant for loss incurred in removing and/or reinstalling equipment.

Every precaution for accuracy has been taken in the preparation of manuals and/or software, however, Geokon, Inc. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages or losses that result from the use of the products in accordance with the information contained in the manual or software.

TABLE of CONTENTS

FIGURES

TABLES

1. OPERATING PRINCIPLE

The Geokon Model 4615 Hydraulic Overflow Settlement System is designed to measure settlement in fills, or in the embankment of a dam, where the settlement cell and readout location can be at the same elevation. Based on the U-tube and overflow principle, the system consists of a sealed settlement cell connected via tubing to a remote water readout. The gage is normally read by pumping water through the overflow pipe inside the settlement cell and letting the level in the sight tube stabilize to the same elevation as the overflow pipe. A drain tube allows surplus water from the overflow pipe to flow out of the cell, and a vent line keeps the pressure inside the settlement cell consistent with the atmospheric pressure. Water level can be measured to the millimeter using the graduated scale located on the sight tube. The readout location should be established on stable ground so that the elevation of the readout remains constant. A schematic of a typical installation is shown in Figure 1.

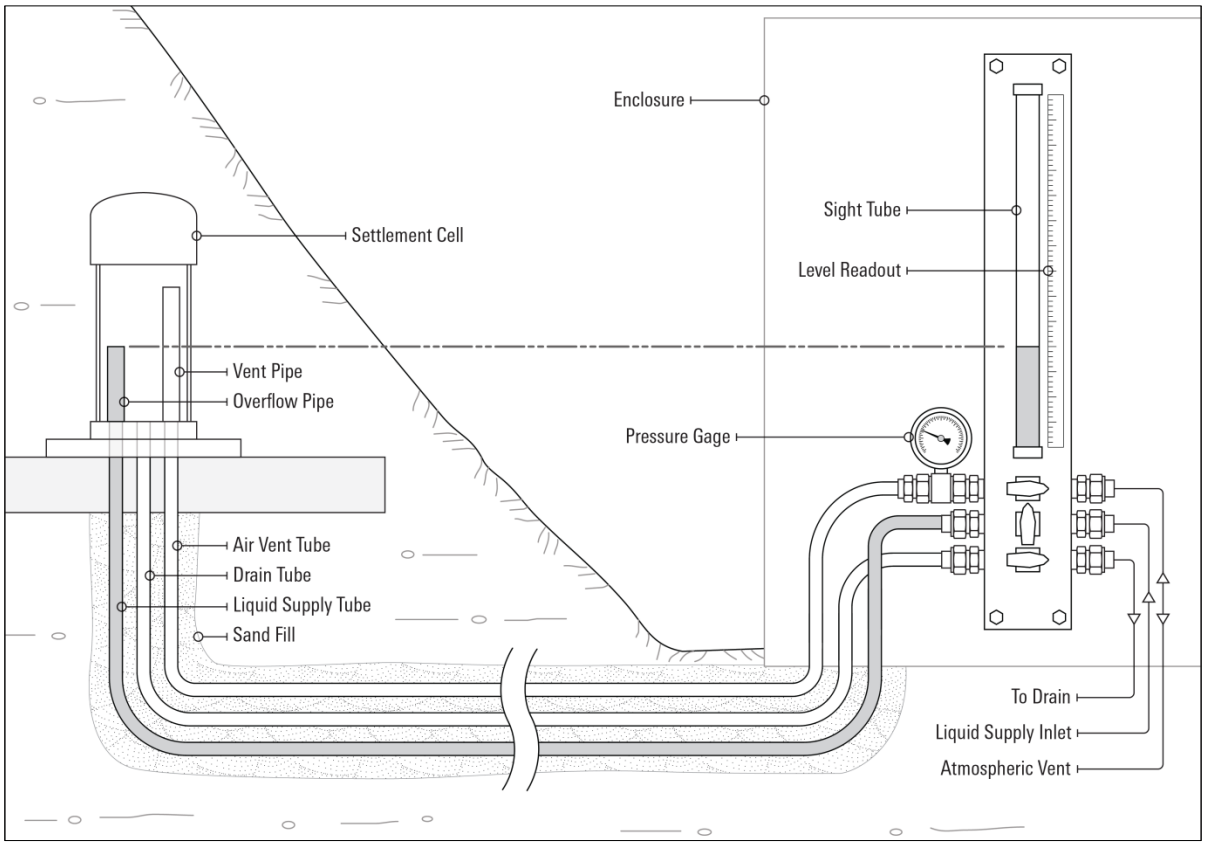

Figure 1 - Hydraulic Overflow Settlement System Diagram

1.1 Advantages and Limitations

- Simple mechanical liquid level system requires no electronic transducers to make reliable, accurate measurements.
- Long-term service life, measurement stability, and reliability.
- Measurements are unaffected by temperature or atmospheric pressure.
- Measurement can be made beneath concrete and earth structures not accessible to other instruments.
- Generally requires the readout to be located at an equal elevation to the settlement cell.

1.2 System Components

Geokon's Model 4615 Overflow Settlement System is made up of three basic components:

- **Readout**

The readout (Figure 2) is mounted on a fiberglass frame and comprises a sight tube and graduated scale to view and measure settlement. Shut off valves are provided to facilitate vent line purging, priming/flushing of the hydraulic overflow pipe, and filling of the sight tube. A cell air pressure gage is installed in the vent line to monitor pressure buildup during priming/flushing of settlement cell.

Figure 2 - 4615 Readout

- **Settlement Cell**

The settlement cell (Figure 3) comprises a sealed, rigid PVC container, which has brass union connections for the overflow pipe, vent line, and drain tube. The height from the bottom of the cell to the top of the drainpipe is 165 mm (6.5").

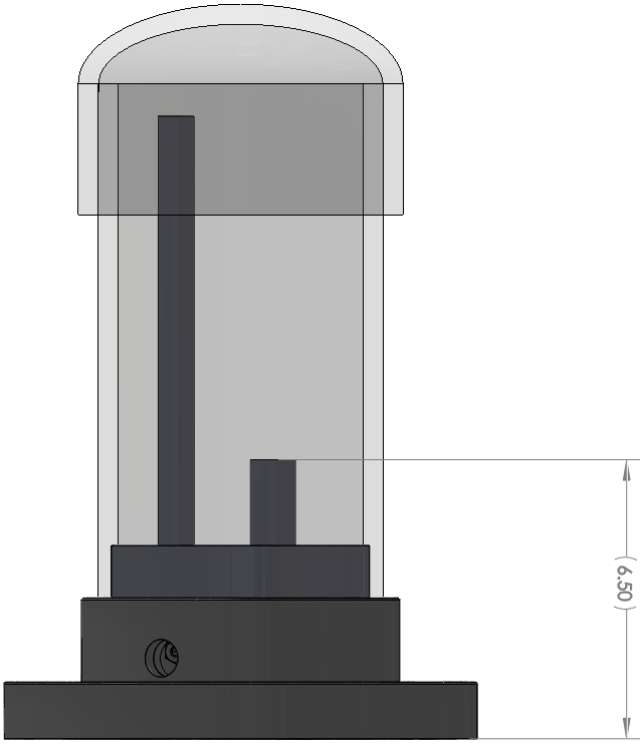

Figure 3 - Settlement Cell

- **Tubing**

The tubing pictured in Figure 4 connects the settlement cell to the readout in the manner detailed in Table 1.

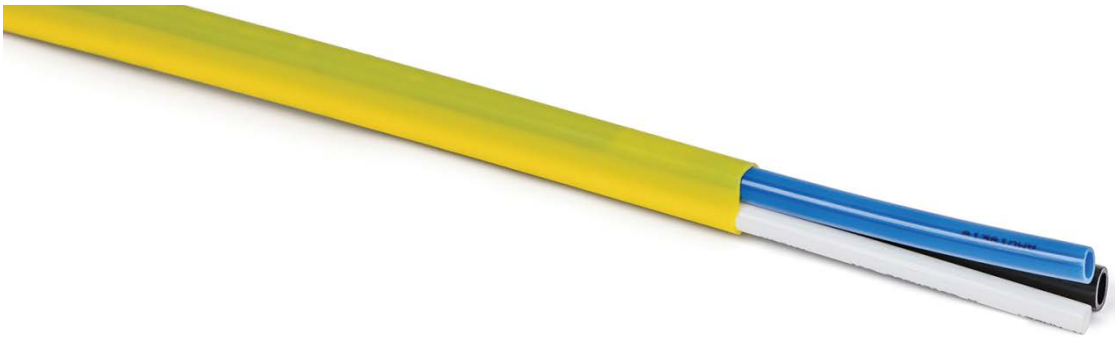

Figure 4 - Tubing Bundle

Diameter	Color	Connection
1/4"	White	Vent
5/16"	Blue	Supply
3/8"	Black	Drain

Table 1 - Tubing Connection Details

1.3 Additional Components Required (Customer Supplied)

- **Compressed Air**

Regulated compressed air (20 psi maximum pressure) is required to blow out the vent line.

- **Fluid Supply Pump**

A fluid supply pump (20 psi maximum pressure) is required to flush/prime the system, along with a sufficient length of flexible tubing to connect the pump to inlet valve on the readout.

- **Solution of Propylene Glycol and De-aerated Water**

It is highly recommended that a solution of 50% Propylene Glycol and 50% de-aerated water be used to fill and flush the system. Pure de-aerated water should only be used if there is **NO** chance of freezing temperatures occurring. A fluid supply equal to approximately 140% of the settlement cell's capacity is required during operation. (See Table 2 in Section 3 for specific volumes.) A deaerator may be purchased from Geokon to de-aerate water on site (Geokon Model 2100).

- **Instrument House**

An instrument house should be constructed on stable ground, at the same level as the anticipated settlement point. See Section 2.2 for more information.

2. INSTALLATION PROCEDURES

2.1 List of Installation Tools Required

For Installation of the Settlement Cell:

- Electric Drill
- 22 mm (7/8") drill bit
- Marker pen
- Two 914 mm (36") square pieces of 19 mm (3/4") thick marine plywood
- Mounting hardware to mount settlement cell to plywood
- 18 × 100 mm (3/4"× 4") bolts

For Installation of the Readout:

- 11 mm (7/16") wrench
- Measuring tape
- Level

2.2 Instrument House

It is recommended that the settlement cell be installed only after the construction of an instrument house at a suitable location.

The instrument house should be constructed on stable ground, at the same level as the anticipated settlement point, near the downstream face of the dam. The instrument house should be large enough to accommodate the readout(s), and should have an entry duct for the settlement cell tubing.

Settlement is measured with respect to the instrument house. A survey marker pin should be provided at a suitable location on the instrument house, preferably on the roof. The survey pin position and elevation should be determined immediately after installation and checked periodically. This will enable the settlement measurement to be corrected for any movement of the instrument house.

2.3 Settlement System Installation

PLEASE NOTE: The collapse pressure rating of the settlement cell is 80 psi. In some applications, it may be desirable to encase the settlement cell and base plate in concrete for protection from compaction equipment and/or excess soil pressure.

Installation of the settlement system is as follows:

1) Construct a 914 mm (36") square base plate out of two layers of 19 mm (3/4") thick marine plywood.

2) Center the settlement flange on the plywood.

3) Mark the location of the holes in the flange.

4) Remove settlement cell and drill 22 mm (7/8") holes where marked. Figure 5 shows the completed base plate.

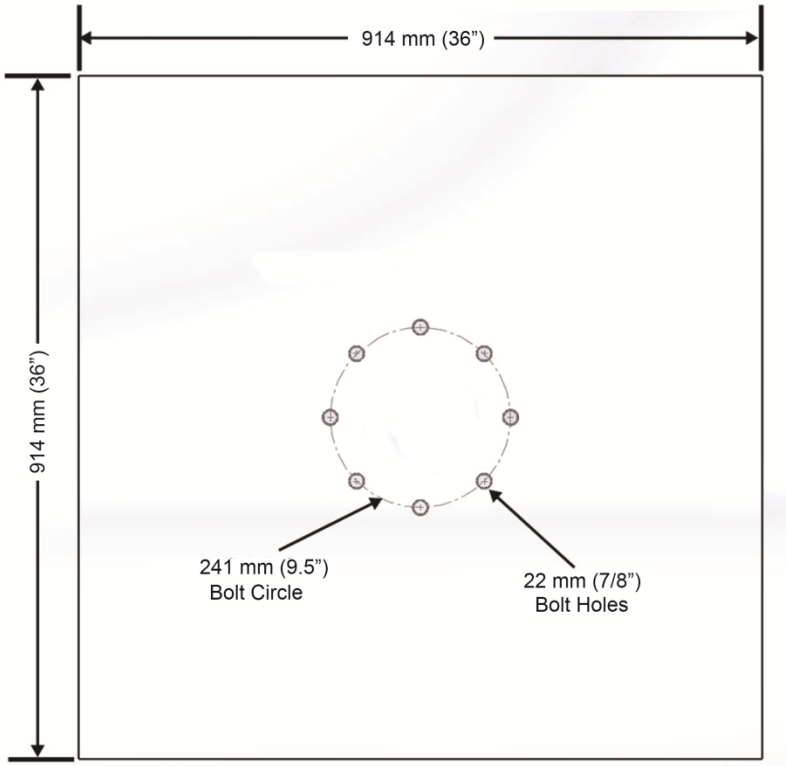

Figure 5 - Base Plate Diagram

5) The settlement cell is mounted to the base plate using 18 × 100 mm (3/4" × 4") user supplied bolts.

6) Excavate an area to accommodate the settlement cell and base plate. Position the settlement cell where settlement is to be monitored.

7) Excavate a gradually sloped trench, 500 mm (20") wide by 500 mm (20") deep, from the settlement cell to the instrument house. (Trenches in earth dam embankments should never penetrate entirely through the clay core.) A gradual slope assists proper drainage as well as avoiding the formation of air pockets in the tubing. **At no point should the tubing be higher than the readout location.**

   The slope of the trench is determined by the expected settlement/heave. If only settlement is expected, the settlement cell should be installed at an elevation of approximately 200 mm (8") below the top of the sight tube.

8) Prepare the surface of the trench by removing any rough or sharp objects that may pinch or puncture the tubing. Use a compacter to smooth and compact the trench; the trench should not undulate.

9) Route the tubing from the settlement cell to the instrument house location. The tubing should be installed in the trench by rolling the reel on its side; it should not be unwound from a stationary position as this can cause the tubing to twist and kink. Tubes should be laid flat on the ground, side by side, without touching or crossing each other. Care should be taken to

avoid kinks or sudden bends in the tubing. Create S-bends in the tubing to allow for ground movement.

Caution! Do not allow dirt or debris to enter the nylon tubing during the installation process. It is recommended that the ends of the tubing be sealed with tape or by other means until it is connected to the settlement cell/readout.

10) Mount the readout(s) vertically on the instrument house wall. Use a level to ensure the readout is mounted as close to vertical as possible. Mounting the readout on a sliding channel (as shown in Figure 6) can aid in adjustment of the zero position.

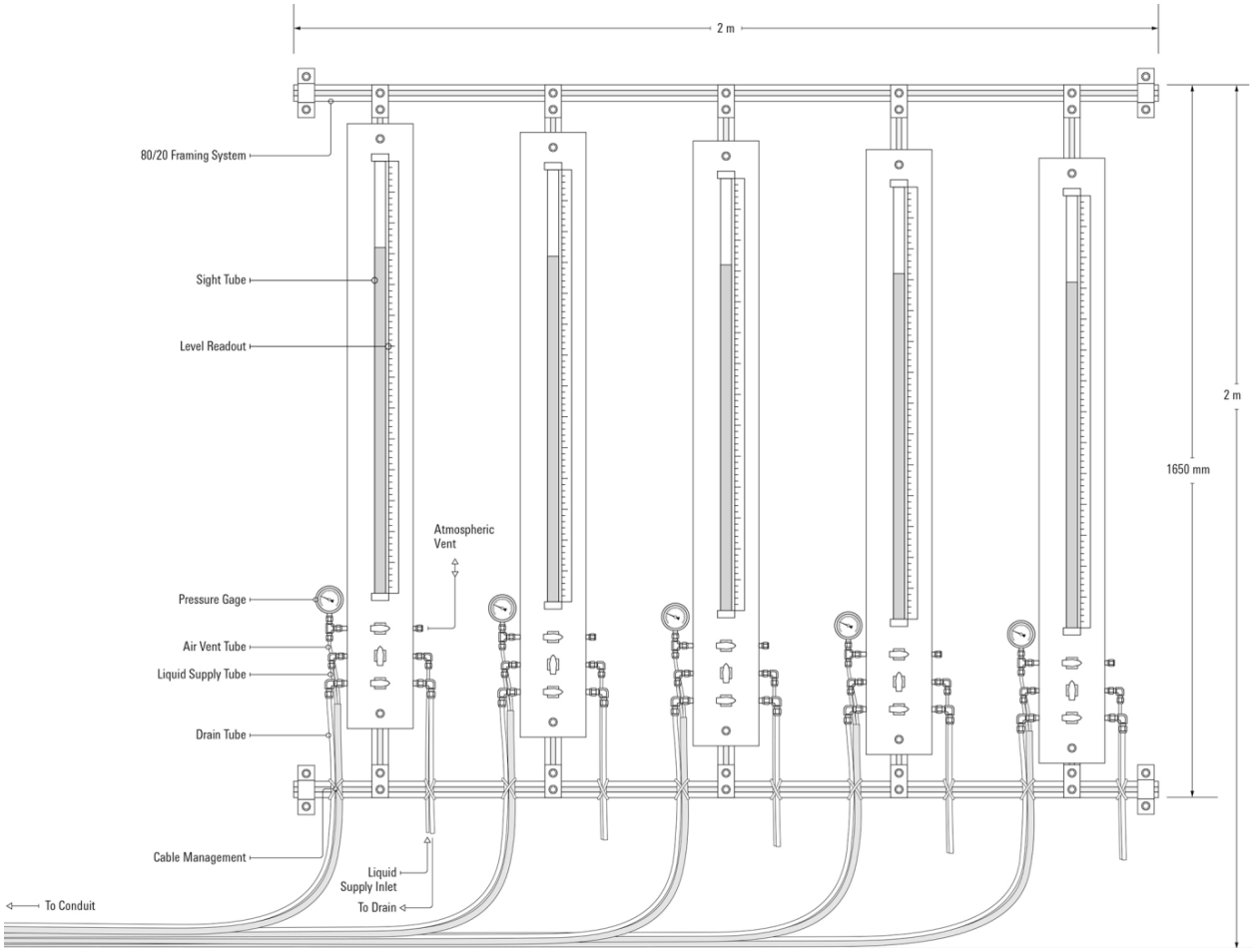

Figure 6 - Readouts Mounted on Aluminum Channels

11) Pass the ends of the tubing through the entry duct in the instrument house and connect them to the readout.

12) To protect the tubing from damage, backfill the trench with at least 100 mm of compacted sand. If desired, bentonite plugs can be constructed at suitable intervals along the trench to prevent water migration.

    If the tubing is not buried, it should be adequately supported along its length to prevent undulations. It should also be protected from direct sunlight and insulated from rapid temperature fluctuations.

3. SYSTEM OPERATION

NOTE: The entire operating procedure, as detailed below, must be followed each time a reading is taken.

1) Make sure the sight tube and pump valves are tightly closed.

2) Open the external vent valve.

3) Blow compressed air (20 psi maximum) through the external vent valve for one to two minutes. Watch the cell air pressure gauge while blowing air through the system, if the reading reaches 20 psi, stop the airflow and check the tubing for blockages.

4) Close the external vent valve.

5) Make sure the external drain tube is free to atmosphere. (A bucket or other container can be placed under the drain tube to collect the fluid as it flows out of the system.)

6) Connect a fluid supply pump to the external pump valve.

7) Open the external pump valve.

8) Use Table 2 to determine how much fluid will be needed to prime and flush the system.

Length of Line								
[feet]	100	200	300	400	500	600	700	800
[meters]	30	60	90	120	150	180	210	240
Flush Volume								
[gallons]	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2
[Liters]	0.8	1.5	2.6	3.4	4.2	4.9	5.7	6.8
Settlement Cell Sizing								
4615-1 (2.5 Liter)								
4615-2 (5 Liter)								
4615-3 (10 Liter)								

Table 2 - 4615 Settlement Cell Sizing and Fluid Flush Volumes

9) Pump the correct amount of fluid through the system. While pumping, slightly open the sight tube valve to fill the sight tube with fluid. Watch the fluid as it rises inside the sight tube and close the sight tube valve once the fluid reaches the top. Make sure to monitor the cell air pressure gauge while flushing the system, if the reading reaches 20 psi, stop pumping until the excess pressure dissipates. More than one system may be flushed at a time as the capacity of the pump allows.

10) Once the correct volume of fluid has been flushed through the system, close the external pump valve. The pump may be shut off only after closing the external pump valve.

11) Open the external vent valve.

12) Let the system drain for a minimum of 20 minutes.

13) Once fluid ceases to flow from the drain tube, open the sight tube valve.
WARNING! Do not open sight tube valve while there is still pressure in the system.

14) Wait a minimum of five minutes, or until the sight tube shows no fluid movement, before taking a reading.

15) To take a reading: Slide the plastic cursor along the sight tube until the top of the cursor is aligned with the bottom of the meniscus inside the tube. Sight across the top of the cursor to the scale behind the sight tube. Record the reading. When taking a reading the user should bring their eye level to the bottom of the meniscus; this will ensure the most accurate result by avoiding any parallax error.

    It is recommended that a second reading is taken five minutes later and compared to the first. If the readings are identical, the fluid in the sight tube is fully settled and the readings are accurate. If the two readings differ, wait another five minutes and then take another reading. Continue this process until two identical readings are obtained.

4. MAINTENANCE

Each use:

1) Blow out the vent line with compressed air.

2) Flush/Prime the fluid supply.

Seasonal:

The growth of algae can be prevented by dissolving a crystal of copper sulfate in the liquid or by using commercial grade propylene glycol solutions. Propylene glycol solutions can also be used to prevent freezing. The use of distilled water, rather than tap water, is recommended.

5. TROUBLESHOOTING

If the water does not flow through the system as expected, ensure that none of the following has occurred:

- Pinched or kinked nylon tubing.
- Blocked vent or drain tubes.
- Blocked supply line.
- Foreign material in the system.

APPENDIX A. SPECIFICATIONS

Standard Range:	1 meter (3.28 ft.)[1]
Resolution:	1 mm (0.04")
Accuracy:	±5 mm (±0.2")[2]
Temperature Range:	-20 to +80 °C
Settlement Cell Dimensions Length x Diameter (5L model):	450 × 200 mm (18" × 8")
Readout Dimensions Length x Width x Depth:	1650 mm × 250 mm × 125 mm (65" × 10" × 5")

Table 3 - Specifications

[1] Other ranges available on request.

[2] Laboratory accuracy. Total system accuracy is subject to site-specific variables.

APPENDIX B. 4615-5 SPLICE KIT

Model 4615-5 Splice kit components are shown in Figure 7.

Figure 7 - Model 4615-5 Splice Kit

Splice kit installation is as follows:

1) Strip the outer jacket of the tubing back approximately 63 mm (2.5").

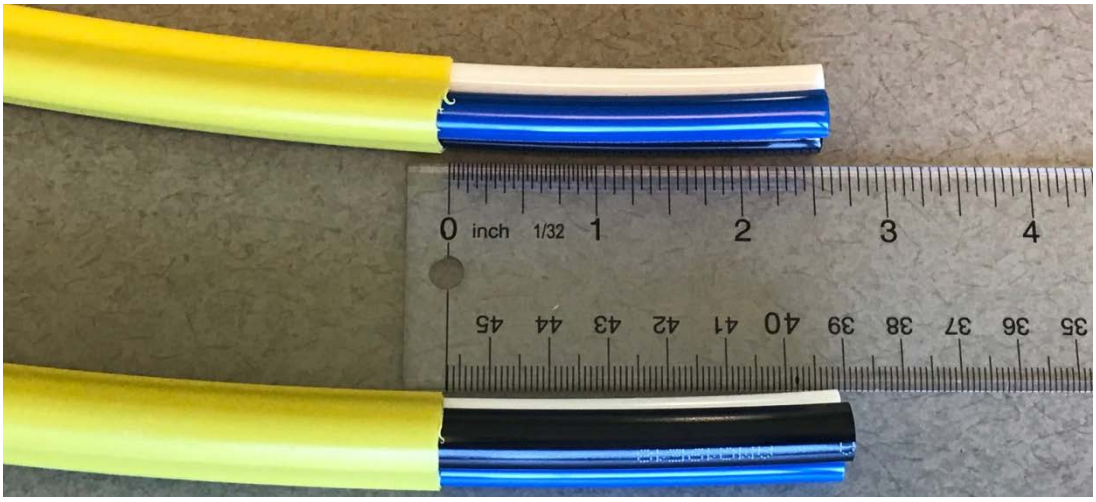

Figure 8 - Outer Jacket of Tubing Removed

2) Slide the foam mesh sleeve over the end of one of the bundles of tubing (Figure 9).

Figure 9 - Foam Mesh Sleeve

3) Use the Swagelok fittings to connect like colored tubes together. (See Appendix C for Swagelok instructions.) Center the Swagelok fittings inside the enclosure (Figure 10).

Figure 10 - Swagelok Fittings Installed

4) Slide the foam mesh sleeve over the Swagelok connectors.

5) Remove one-quarter of each foam insert and set them aside. Place the larger pieces of the foam inserts under the tubing in the ends of the enclosure as shown in Figure 11.

Figure 11 - Large Pieces of Foam Installed

6) Place the small foam inserts over the tubing so that they fit back into the larger inserts as they would have before they were separated. Carefully close the enclosure, making sure that the foam inserts stay inside the recessed areas at the ends of the enclosure. Press the enclosure together until it clicks into place.

7) Prepare the urethane filler according to the instructions below:

ATTENTION! Wear the provided disposable gloves while performing the following operations.

With the encapsulant tube still in the mixing bag, point the heat-sealed end of the mixing tube away from yourself and others.

Flip the white barrier wafer with your thumb and forefinger to allow the two-part urethane encapsulant to mix. Shake the tube with an up and down motion. Refer to Table 4 for the appropriate mix time.

NOTE! The encapsulant cures very fast! Be prepared to work quickly and keep the mixing time to a minimum. The mesh bag is to keep the splices from touching the sides of the molds. It may delay the filling of the enclosure and could be eliminated to speed things up.

Temperature:	Below 60 °F	Between 65 °F and 85 °F	Between 86 °F and 100 °F
Mix Time:	Use alternate mixing method shown below	**Shake for one minute**	**Shake for 30 seconds**
Alternative Mixing Method: At temperatures below 65 °F, **DO NOT SHAKE.** After flipping the white barrier, remove the tube from the mixing bag, cut the heat-sealed end, and remove the white barrier with the wooden paddle. Stir vigorously with the wooden mixing paddle for one minute to blend the two components together. Pour into enclosure.			

Table 4 - Encapsulant Mixing Guide

8) Once the urethane is mixed, open the mixing bag and unscrew the cap. Fill the enclosure with encapsulant. Slightly tilt the enclosure to let the air pockets escape from the enclosure.

9) Close the enclosure and insert the blue plug into the filling hole. The completed splice is shown in Figure 12.

Figure 12 - Completed Splice

10) Allow to encapsulant to solidify and cool before installation or burial.

APPENDIX C. SWAGELOK TUBE FITTING INSTRUCTIONS

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

C.1 Installation

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

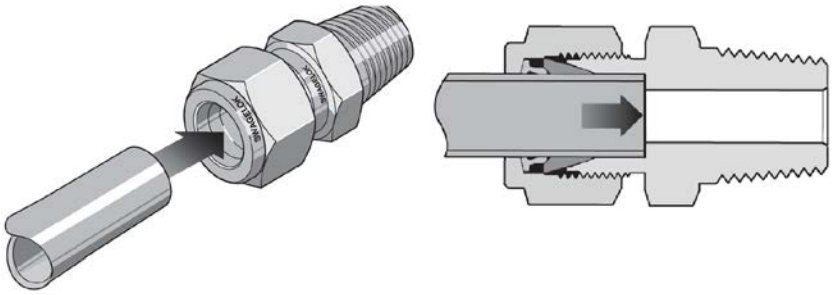

Figure 13 - Tube Insertion

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.

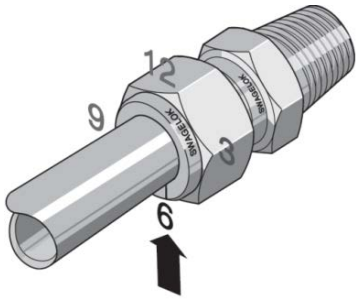

Figure 14 - Make a Mark at Six O'clock

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.)

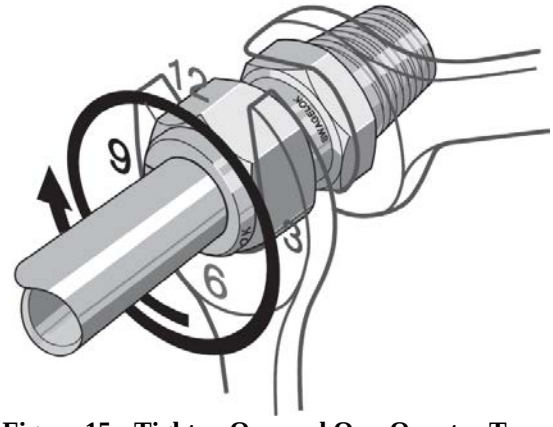

Figure 15 - Tighten One and One-Quarter Turns

C.2 Reassembly Instructions

Swagelok tube fittings may 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 16 - 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.

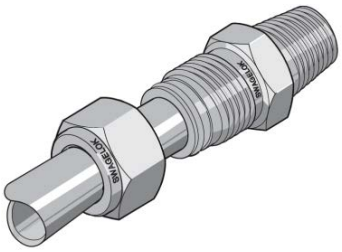

Figure 17 - Ferrules Seated Against Fitting Body

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.

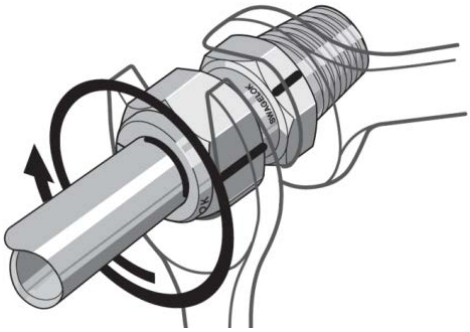

Figure 18 - Tighten Nut Slightly