SUMITOMO RECOMMENDED PROCEDURE

SRP SP-F04-031

FutureFLEX® AIR-BLOWN FIBER® SOLUTIONS

TUBE CABLE SPLICING PROCEDURES

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1.0 General

1.1 This procedure describes the standard techniques for stripping FutureFLEX® Air-Blown Fiber (ABF) tube cable jackets and coupling tubes together in various in-line splice arrangements for 7, 12, 19 and 24 tube cables.

1.1.1 The *Preferred In-line Splice Arrangement* staggers each Tube Coupling so it is not contacting the adjacent Tube Coupling. This arrangement produces a slim, neat, and well organized splice.

1.1.2 The *"Unique" Stagger Arrangement* places the collar of one Tube Coupling in contact with the collar of the adjacent Tube Coupling. This arrangement is required if accomplishing an in-line splice within a Tube Cable Splice Kit or Splice Case. This arrangement also produces a neat, well organized splice.

1.1.3 The *Odd-Even Arrangement* places the odd-numbered Tube Couplings to one side of the center Tube Coupling and the even-numbered Tube Couplings to the other side of the center Tube Coupling. This arrangement produces a very neat and well organized splice and results in a very short splice length.

1.1.4 The *All-in-a-Row Arrangement* places all the Tube Couplings in the same row. This arrangement is easy to make but has several disadvantages. A bulky arrangement is produced, access to inside Tube Couplings can be difficult, and the overall splice length can be long.

1.2 The tools and techniques required to strip tube cable jackets are similar to that used with conventional cabling. However, extra care must be used to avoid damaging the inner tubes.

1.3 In-line tube cable splicing is typically accomplished within indoor or outdoor Tube Distribution Units (TDUs), Splice Cases, or indoor Fiber Termination Units (FTUs).

2.0 Safety Precautions

CAUTION: *When working with the different metallic / armored tube cables, always exercise extreme caution. Sharp edges will be present whenever the interlocked galvanized steel is exposed.*

2.1 The use of personnel safety equipment is strongly recommended while cutting and stripping tube cable ends and working around metallic tube cable elements. This includes the use of cut-resistant Kevlar gloves and eye wear.

3.0 Reference Documents

3.1 Sumitomo Recommended Procedure, *FutureFLEX Indoor, Wall-Mount TDU Installation Procedures,* SRP SP-F04-005.

3.2 Sumitomo Recommended Procedure, *FutureFLEX Tube Cable Installation Procedures,* SRP SP-F04-008.

3.3 Sumitomo Recommended Procedure, *FutureFLEX Splice Case Kit Installation Procedure,* SRP SP-F04-015.

3.4 Sumitomo Recommended Procedure, *FutureFLEX Tube Cable Splice Kit Installation Procedure,* SRP SP-F04-016.

3.5 Sumitomo Recommended Procedure, *FutureFLEX Grounding & Bonding Metallic Tube Cables,* SRP SP-F04-030

4.0 Equipment / Tools Required

The following equipment, tools, and materials are required to complete this procedure:

4.1 Felt Tip Pen / Marker

4.2 Tape Measure

4.3 Utility Knife with Hook Blade

4.4 Tube Cable Cutter (BETL03) and or
(BETL64)

4.5 Tubing Cutter (BETC001)

4.6 Tube Couplings (DE08MC2)

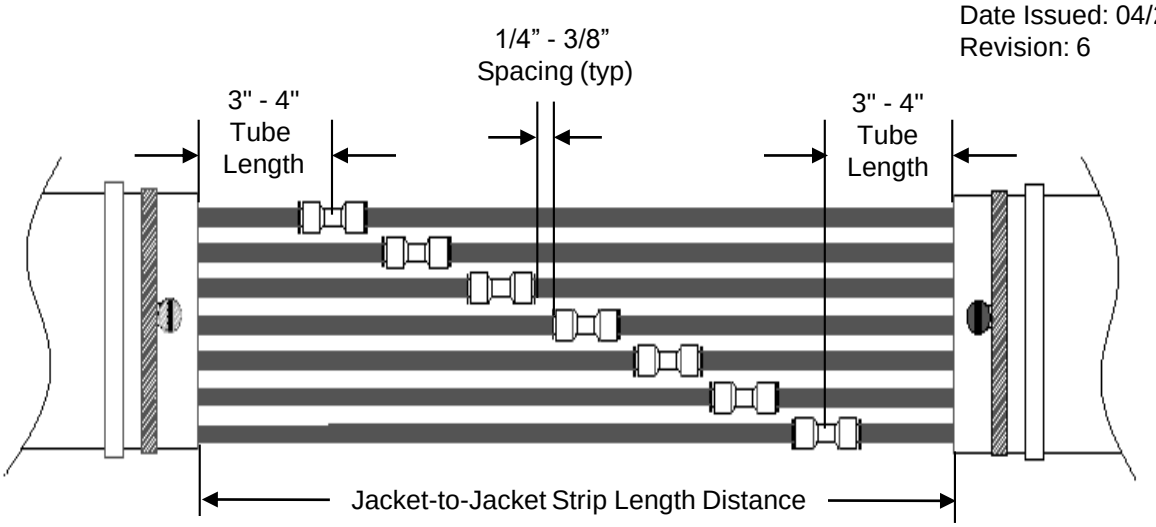


Figure 1
Recommended Distances for Tube Coupling Locations and Spacing

5.0 Equipment Layout

5.1 **See Fig. 1** for the recommended layout of a typical in-line tube cable splice.

5.2 Tube cable splices should always present a neat and orderly appearance. *Above all, however, they must be functional.* Each Tube Coupling must be accessible so it can be easily connected / disconnected in the future. Exact measurements are not critical.

5.3 A Tube Coupling is about 2" long. **See Fig. 2.**

End Collars Compressed

End Collars Expanded

Figure 2
Tube Coupling Dimensions

5.4 From the stripped end of a tube cable jacket to the center of the first Tube Coupling, the minimum recommended tube length for an average person to comfortably connect and disconnect a Tube Coupling is about 3" - 4". A 3" tube length is workable but tight. A 4" or longer tube length is better.

5.5 The recommended minimum spacing between the end of one Tube Coupling to the end of an adjacent Tube Coupling is about 1/4" - 3/8".

6.0 Preliminary Steps

6.1 Refer to Sumitomo Recommended Procedure SRP SP-F04-005 for guidance on locating a TDU. Key points:

6.1.1 Chose a TDU location that provides for best routing / mounting of tube cables into and out of the TDU.

6.1.2 Do not exceed the tube cable's minimum bend radius requirements; 20X tube cable OD during installation and 10X tube cable OD after installation.

6.2 Refer to Sumitomo Recommended Procedure SRP SP-F04-008 for guidance on routing tube cables to TDUs. Key points:

6.2.1 It is recommended to provide at least 3' of extra tube cable length at every TDU entry point for tube cable splicing purposes.

6.2.2 **Very Important Point.** Always verify that one tube cable segment will mate to the next tube cable segment so that their tubes will not be crossed or twisted when coupled. Correct Tube Orientation is particularly important at all in-line splice points. Refer to Sumitomo Recommended Procedure, *FutureFLEX Tube Cable Installation Procedures,* SRP SP-F04-008.

6.3 Refer to Sumitomo Recommended Procedure SRP SP-F04-015 for guidance on accomplishing an in-line tube cable splice using a Splice Case Kit.

6.4 Refer to Sumitomo Recommended Procedure SRP SP-F04-016 for guidance on accomplishing an in-line tube cable splice within a Tube Cable Splice Kit.

6.5 Refer to Sumitomo Recommended Procedure SRP SP-F04-030 for guidance on Grounding and Bonding procedures for metallic tube cables. Key points:

6.5.1 Additional tube cable length must be made available inside the TDU for attachment of Grounding and Bonding hardware (i.e.: Shield Connector Assemblies).

6.5.2 This extra tube cable jacket length can reduce the amount of space available inside the TDU to couple the tubes.

7.0 Determining Tube Cable Strip Length

Note: *Determining available tube cable Strip Length inside a TDU is <u>the</u> "critical" first step of any in-line splicing process.*

7.1 Loosely place tube cables into TDU through designated entry points.

7.2 Allow at least 1"-2" of outer jacketing material on both tube cables to be left inside TDU. Mark each jacket. **See Fig. 3.**

7.3 Measure distance between these two points to determine available tube cable Strip Length. Record this dimension and mark both jackets.

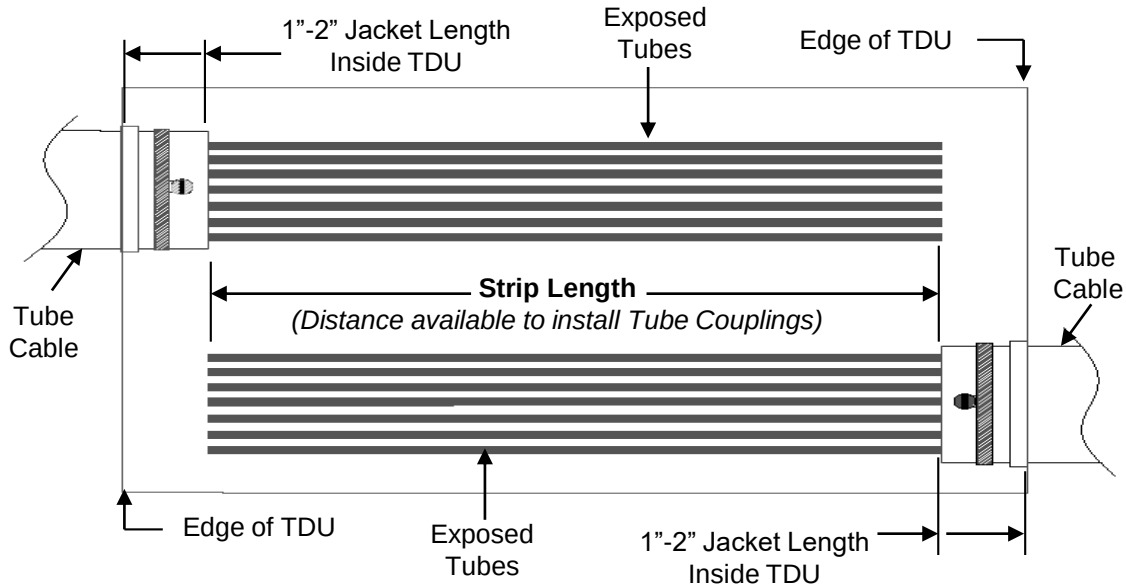


Figure 3
Determining Available Tube Cable Strip Length

8.0 Stripping Tube Cable Jackets

8.1 Remove both tube cables from TDU and use Tube Cable Cutter (BETL03 and or BELT64) to cut tube cables to length.

CAUTION: *<u>Always</u> lightly score tube cable jackets to avoid cutting / nicking interior tubes.*

8.2 Use Hook Blade Knife to lightly score outer jacket at the 1"-2" mark.

8.3 Locate ripcord inside tube cable end. Use Hook Blade Knife to slit jacket about 6"-8" and bring ripcord up through slit. **See Fig. 4.**

8.4 Grab ripcord and pull, cutting through outer jacket. Pull ripcord slightly beyond score mark.

8.5 Carefully separate jacket and remove from tube cable.

8.6 Remove ripcord and tape wrap (water or fire blocking) from around tubes and discard.

8.7 Repeat for other tube cable.

8.8 Re-install both tube cables into TDU, adjust positions to obtain 1”-2” of outer jacket length at entry points, and secure loosely.

Tip: *Individual tubes are numbered every 2”. However, these numbers are sometimes difficult to see once the tube cable is installed inside the TDU. While tube cable is still outside TDU, it is strongly recommended to identify each tube with a larger and more easily read number tag. It will save time in the future.*

Note: *Use hacksaw or equal to cut Interlocked Galvanized Steel armoring and jacket from around the core cable. You may also unwrap the Interlocked Galvanized Steel spiral wrap by finding the end of the armor and unraveling it back to the desired location. Then bend the steel wrap back and forth until it breaks and remove it from around the core cable. Wrap all sharp / exposed metal edges with Electricians Tape.*

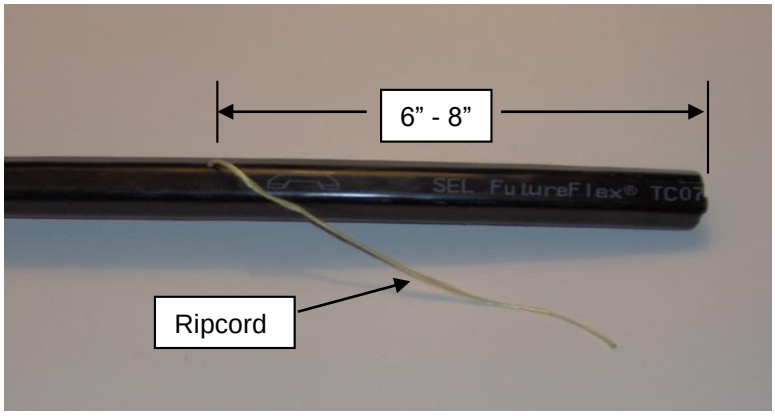


Figure 4
Ripcord Exposed and Ready to Pull

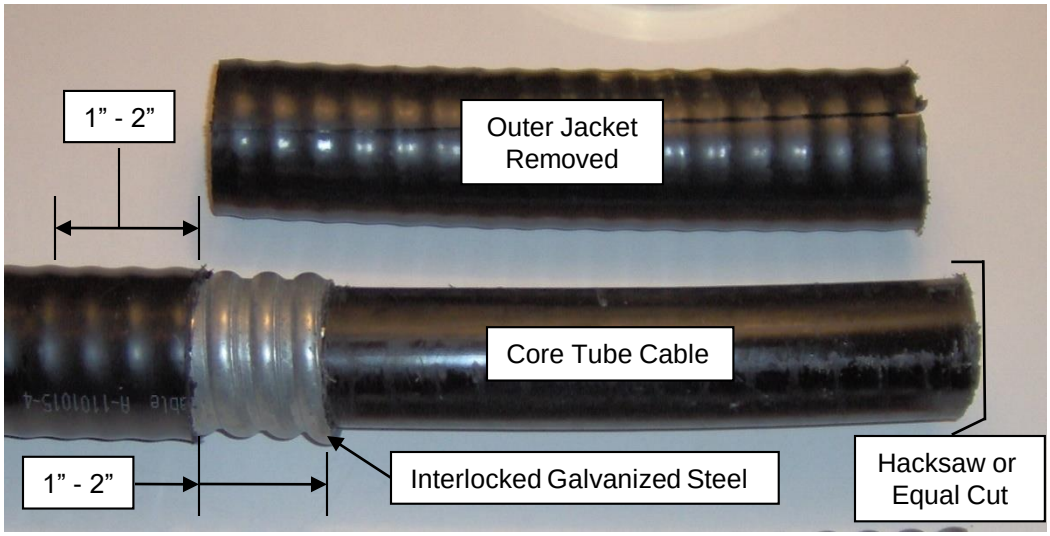


Figure 5
Interlocked Galvanized Steel Tube Cable Outer Jacket and Armor Removed

9.0 Preferred In-line Splice Arrangement for 7-Tube Cable

9.1 **See Fig. 6** for the tube orientation of a 7-tube cable.

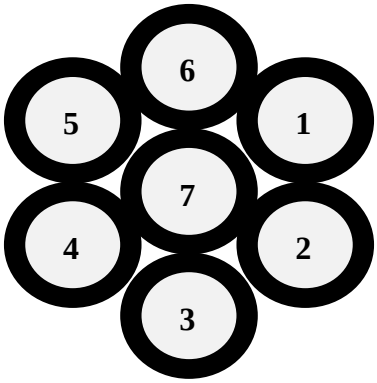


Figure 6
7-Tube Cable Tube Orientation

9.2 Chose one tube cable. Locate, measure, and mark its Tube 7 at one half the Strip Length dimension recorded earlier. **See Fig. 7.**

9.3 Use Tubing Cutter (BETC001) and cut Tube 7 with a straight, clean cut.

9.4 Install Tube Coupling (DE08MC2) on Tube 7. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

9.5 Locate and lay Tube 7 of other tube cable next to installed Tube Coupling. Mark second Tube 7 to coincide with center point of Tube Coupling.

9.6 Use Tubing Cutter and cut second Tube 7 with a straight, clean cut.

9.7 Install second Tube 7 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

Note: *It is always best to cut a tube a little bit long, test fit, and trim shorter to suit. In the event a tube is cut too short or a wrong tube is cut, recovery is possible. Cut tube shorter and install an additional Tube Coupling with a small piece of jumper tubing custom cut to fit to the mating Tube Coupling.*

9.8 Locate and lay Tube 3 of first tube cable next to installed Tube 7 Coupling. **See Fig. 8.**

9.9 Place a Tube Coupling on Tube 3 of first tube cable and adjust its position until there is about 1/4" - 3/8" space between its end and the end of installed Tube 7 Coupling.

9.10 Mark Tube 3 to coincide with the center point of the Tube Coupling.

9.11 Use Tubing Cutter and cut Tube 3 with a straight, clean cut.

9.12 Install Tube Coupling on Tube 3. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

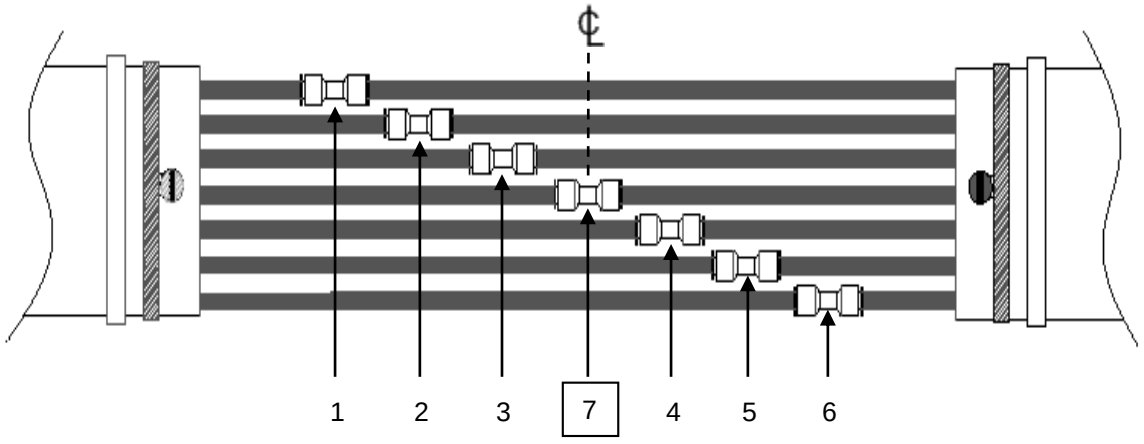


Figure 7
Couple Tube 7 in Center of Strip Length Dimension

9.13 Locate and lay Tube 3 of other tube cable next to installed Tube 3 Coupling. Mark second Tube 3 to coincide with center point of installed Tube 3 Coupling.

9.14 Use Tubing Cutter and cut second Tube 3 with a straight, clean cut.

9.15 Install second Tube 3 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

9.16 Repeat this procedure for Tubes 1 and 2 and Tubes 4 through 6. The "key" is to start in the middle and work toward the ends. **See Fig. 8 and Fig. 9.**

9.17 After all tubes are coupled, make final adjustments to tube and tube cable positions and secure in place to complete the installation. (**See Fig. 18 for an example.)**

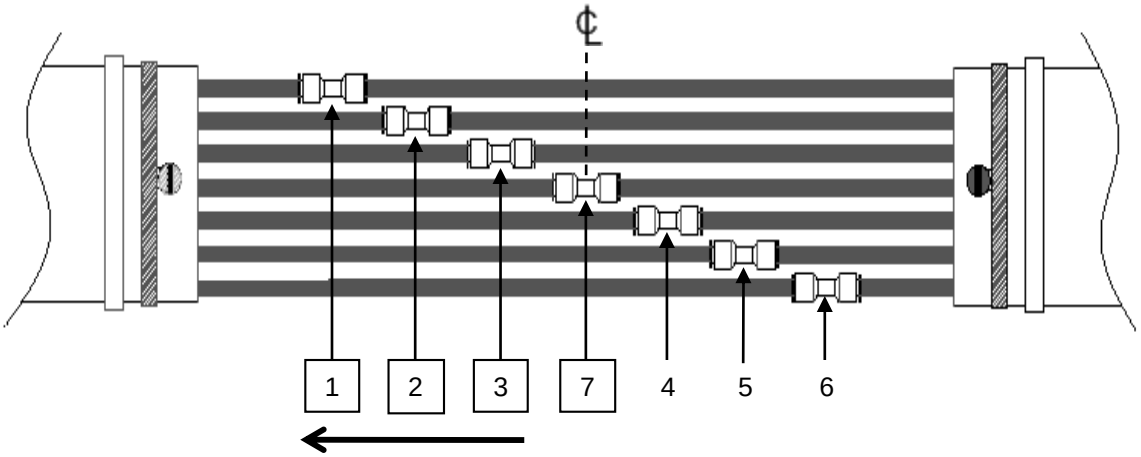


Figure 8
Couple Tubes 1, 2, and 3 to the Left of Center Tube 7 Coupling

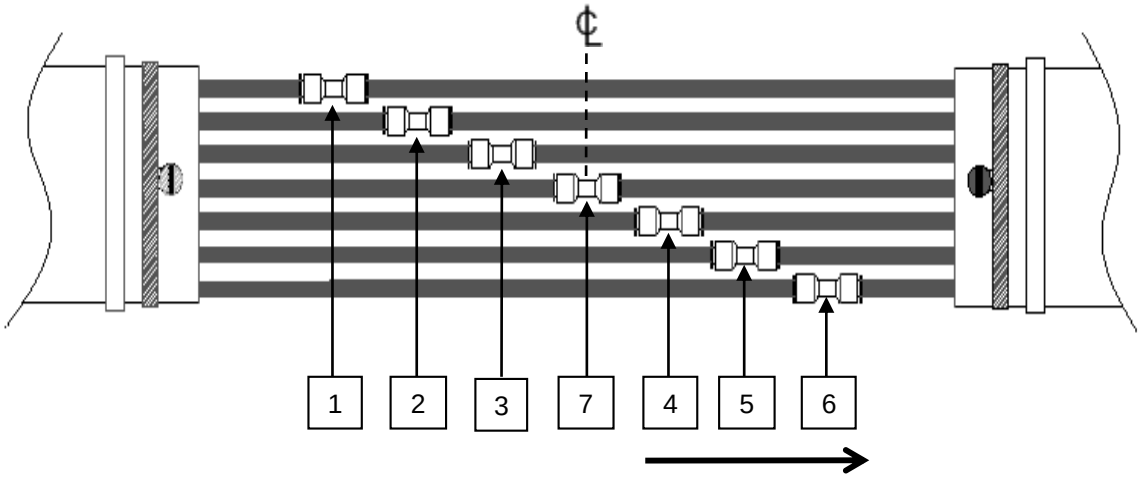


Figure 9
Couple Tubes 4, 5, and 6 to the Right of Center Tube 7 Coupling

10.0 Preferred In-line Splice for 19-Tube Cable – Inner Ring Tubes 13-19

10.1 **See Fig. 10** for the tube orientation of a 19-tube cable.

Note: *Coupling a 12, 19 or 24 tube cable is similar to a 7-tube cable. Start with the Center tube, then work the inner ring tubes, and finish with the outer ring tubes. Be sure to confirm size of TDU will accommodate the cable splice length*

Tip: *Temporarily tape or tie outer ring tubes together into organized groups; e.g.: group Tubes 1 through 6 together and Tubes 7 through 12 together. This helps keep things organized and improves accessibility to inner ring tubes.*

10.2 After determining available Strip Length and preparing both tube cable ends per normal procedures, perform the following steps.

10.3 Chose one tube cable. Locate, measure and mark its Tube 19 at one half Strip Length dimension recorded earlier. **See Fig. 11.**

10.4 Use Tubing Cutter and cut Tube 19 with a straight, clean cut.

10.5 Install Tube Coupling on Tube 19. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

10.6 Locate and lay Tube 19 of other tube cable next to installed Tube Coupling. Mark second Tube 19 to coincide with center point of Tube Coupling.

10.7 Use Tubing Cutter and cut second Tube 19 with a straight, clean cut.

10.8 Install second Tube 19 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

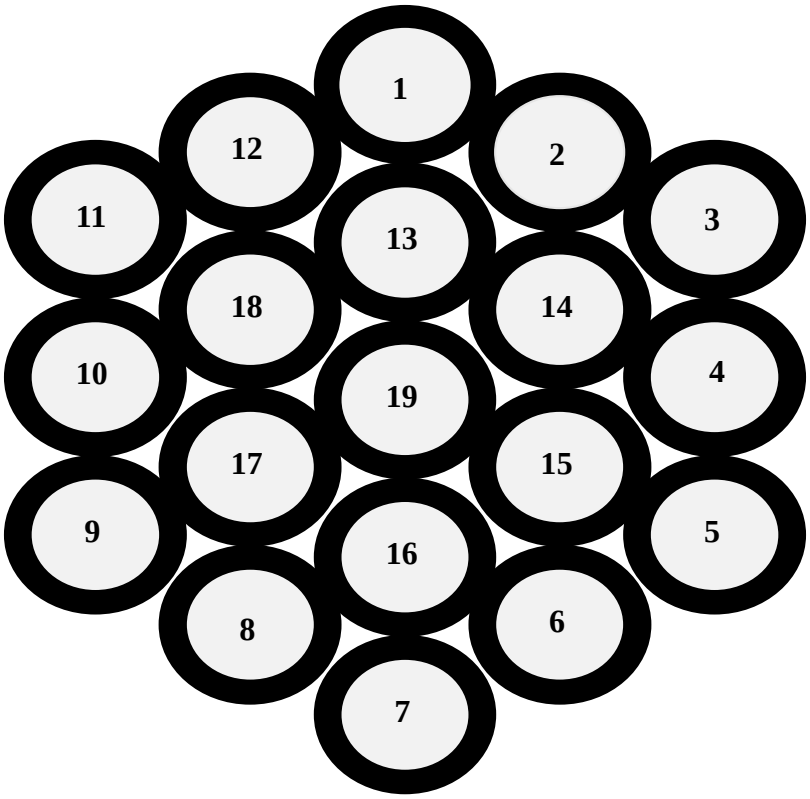


Figure 10
19-Tube Cable Tube Orientation

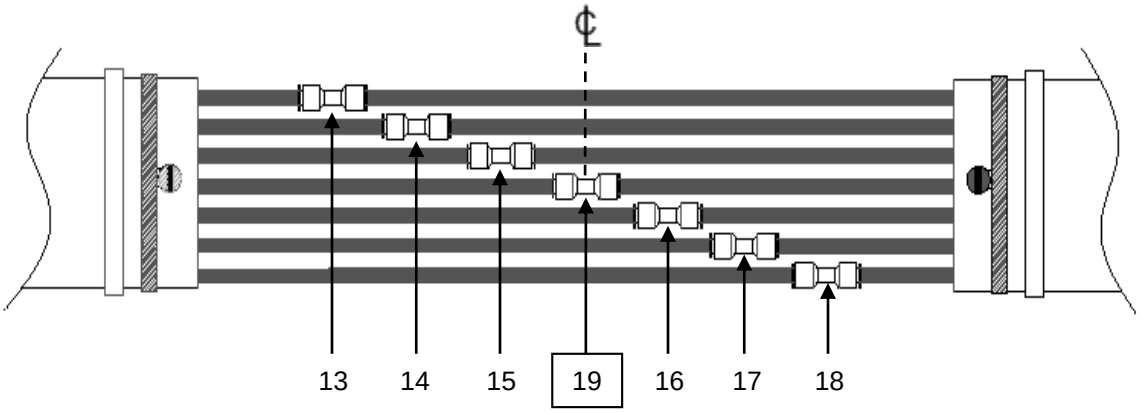


Figure 11
Couple Tube 19 in Center of Strip Length Dimension

10.9 Locate and lay Tube 15 of first tube cable next to installed Tube 19 Coupling. **See Fig. 12.**

10.10 Place a Tube Coupling on Tube 15 and adjust its position until there is about a 1/4”- 3/8” space between its end and the end of installed Tube 19 Coupling.

10.11 Mark Tube 15 to coincide with the center point of the Tube Coupling.

10.12 Use Tubing Cutter and cut Tube 15 with a straight, clean cut.

10.13 Install Tube Coupling on Tube 15. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

10.14 Locate and lay Tube 15 of other tube cable next to installed Tube 15 Coupling. Mark second Tube 15 to coincide with center point of installed Tube 15 Coupling.

10.15 Use Tubing Cutter and cut second Tube 15 with a straight, clean cut.

10.16 Install second Tube 15 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

10.17 Repeat this procedure for remaining inner ring Tubes 13 and 14 and Tubes 16 through 18. Again, the “key” is to start in the middle and work towards the ends. **See Fig. 12 and Fig. 13.**

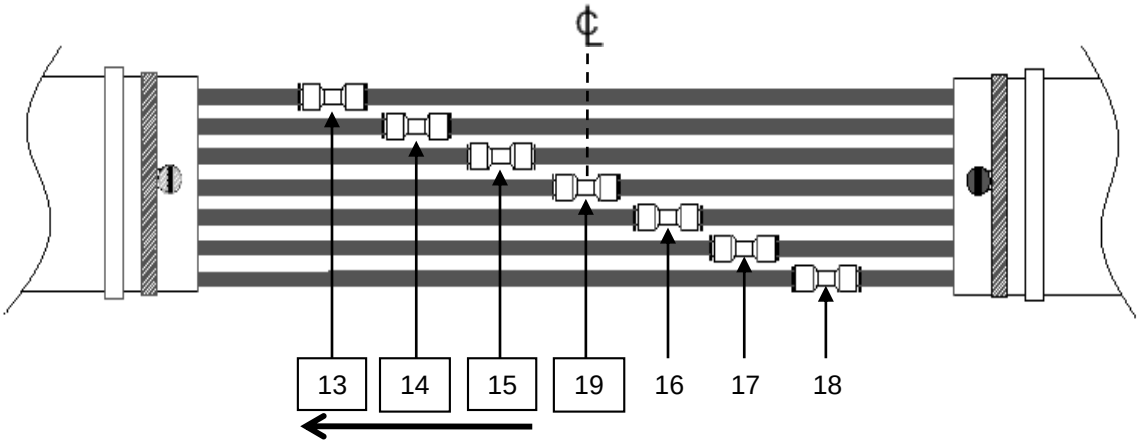


Figure 12
Couple Inner Ring Tubes 13, 14, and 15 to the Left of Tube 19 Coupling

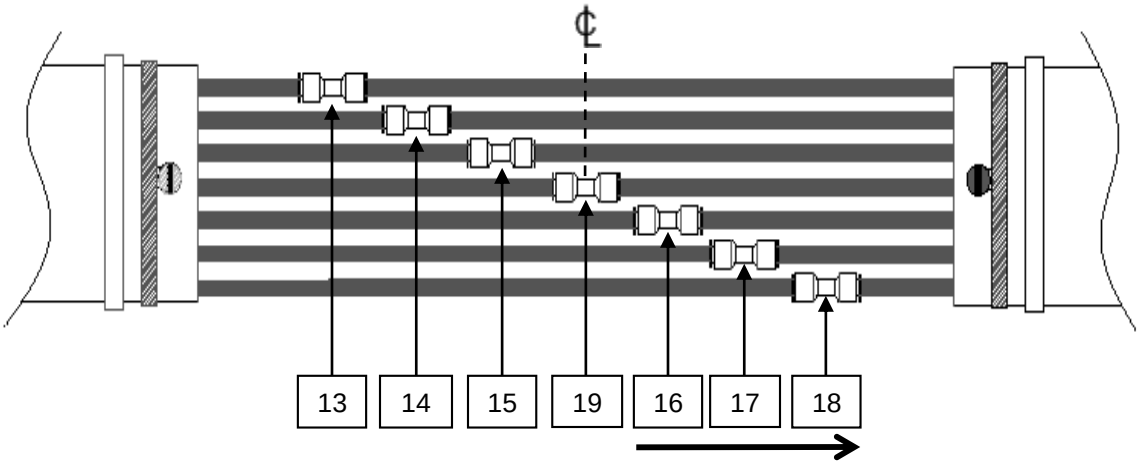


Figure 13
Couple Inner Ring Tubes 16, 17, and 18 to the Right of Tube 19 Coupling

11.0 Preferred In-line Splice for 19-Tube Cable – Outer Ring Tubes 1-6

11.1 With inner ring Tubes 13 through 19 now coupled, begin work on outer ring Tubes 1 through 6 first.

11.2 Locate inner ring Tube 14 Coupling and outer ring Tube 1 of first tube cable. **See Fig. 14.**

11.3 Place a Tube Coupling on Tube 1 and adjust its position until it is located opposite Tube 14 Coupling.

11.4 Mark Tube 1 to coincide with the center of the Tube 14 Coupling.

11.5 Use Tubing Cutter and cut Tube 1 with a straight, clean cut.

11.6 Install Tube Coupling on Tube 1. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

11.7 Locate and lay Tube 1 of other tube cable next to Tube 1 Coupling. Mark second Tube 1 to coincide with center point of installed Tube 1 Coupling.

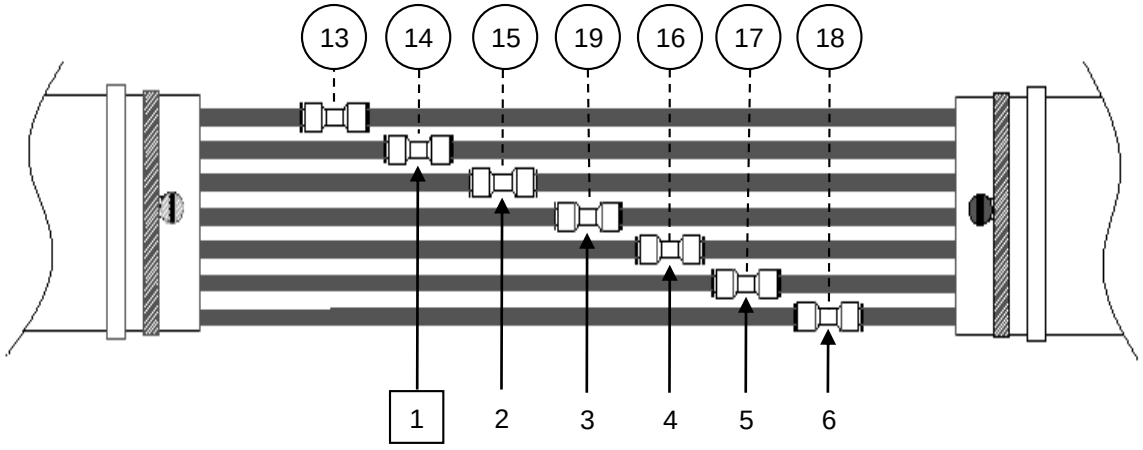


Figure 14
Install Outer Ring Tube 1 Coupling Opposite Inner Ring Tube 14 Coupling

11.8 Use Tubing Cutter and cut second Tube 1 with a straight, clean cut.

11.9 Install second Tube 1 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

11.10 Repeat procedure for Tubes 2 through 6. Adjust each Tube Coupling position until there is about a 1/4"- 3/8" space between its end and the end of the previously installed Tube Coupling. **See Fig. 15.**

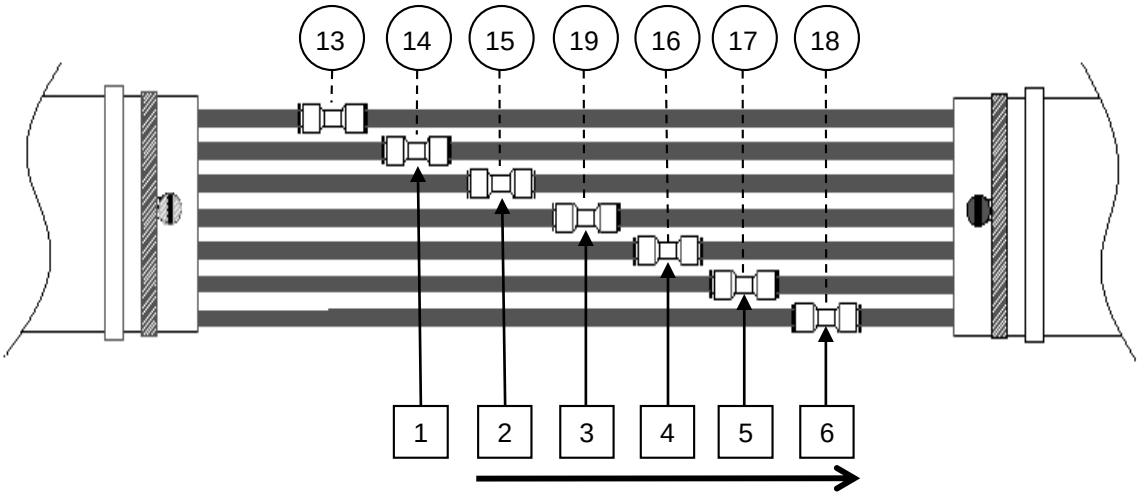


Figure 15
Install Outer Ring Tubes Couplings 2 through 6 to the Right of Tube Coupling 1;
Tube 2 Opposite Tube 15, Tube 3 Opposite Tube 19, and So Forth

12.0 Preferred In-line Splice for 19-Tube Cable – Outer Ring Tubes 7-12

12.1 With outer ring Tubes 1 through 6 now coupled, begin work on outer ring Tubes 7 through 12.

12.2 Locate inner ring Tube 13 and outer ring Tube 7 of first tube cable. **See Fig. 16.**

12.3 Place a Tube Coupling on Tube 7 and adjust its position until it is located opposite Tube 13 Coupling.

12.4 Mark Tube 7 to coincide with the center of the Tube 13 Coupling.

12.5 Use Tubing Cutter and cut Tube 7 with a straight, clean cut.

12.6 Install Tube Coupling on Tube 7. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

12.7 Locate and lay Tube 7 of other tube cable next to Tube 7 Coupling. Mark second Tube 7 to coincide with center point of installed Tube 7 Coupling.

12.8 Use Tubing Cutter and cut second Tube 7 with a straight, clean cut.

12.9 Install second Tube 7 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

12.10 Repeat procedure for Tubes 8 through 12. Adjust each Tube Coupling position until there is about a 1/4"- 3/8" space between its end and the end of the previously installed Tube Coupling. **See Fig. 17.**

12.11 After all tubes are coupled, make final adjustments to tube and tube cable positions and secure in place to complete the installation. (**See Fig. 19 for an example.)**

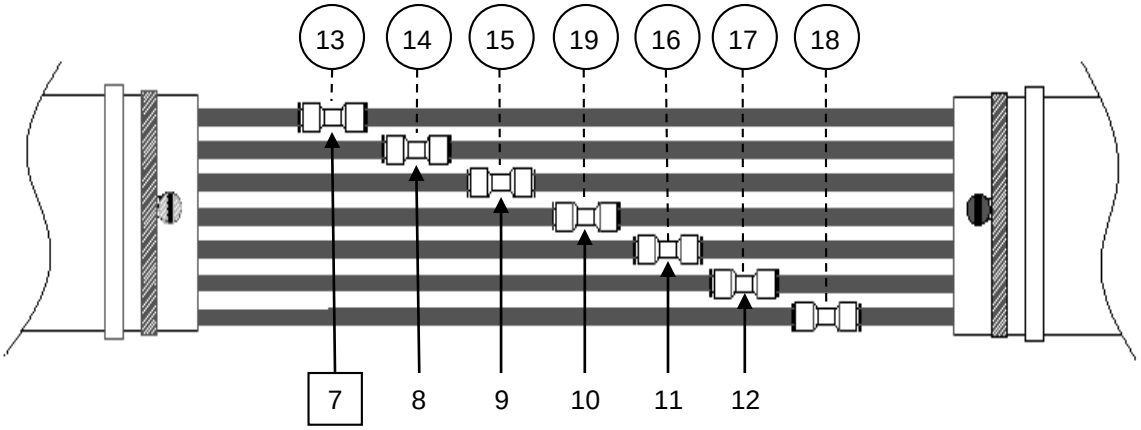


Figure 16
Install Outer Ring Tube 7 Coupling Opposite Inner Ring Tube 13 Coupling

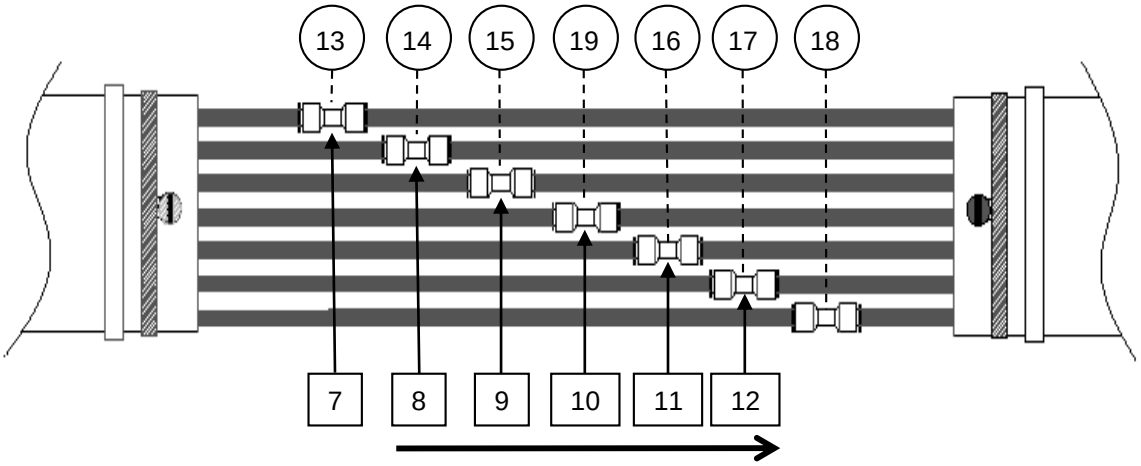


Figure 17
Install Outer Ring Tubes Couplings 8 through 12 to the Right of Tube Coupling 7;
Tube 8 Opposite Tube 14, Tube 9 Opposite Tube 15, and So Forth

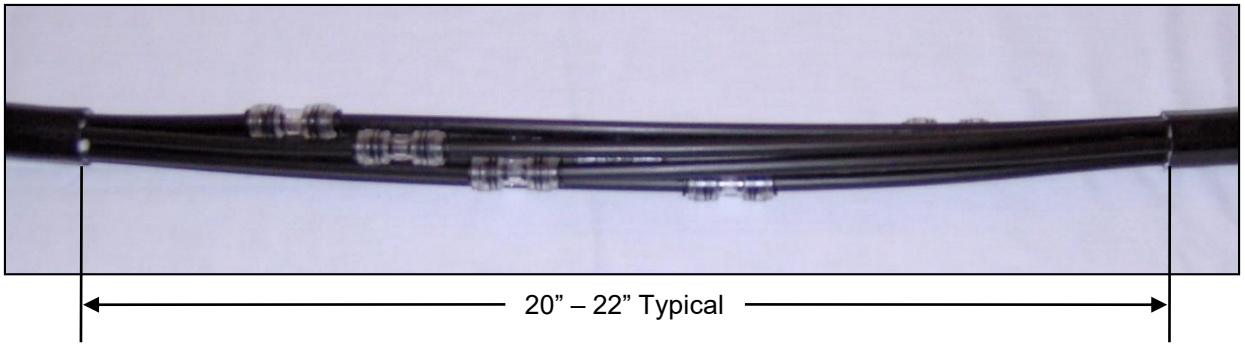


Figure 18
Preferred In-Line Splice for 7-Tube Cable Example

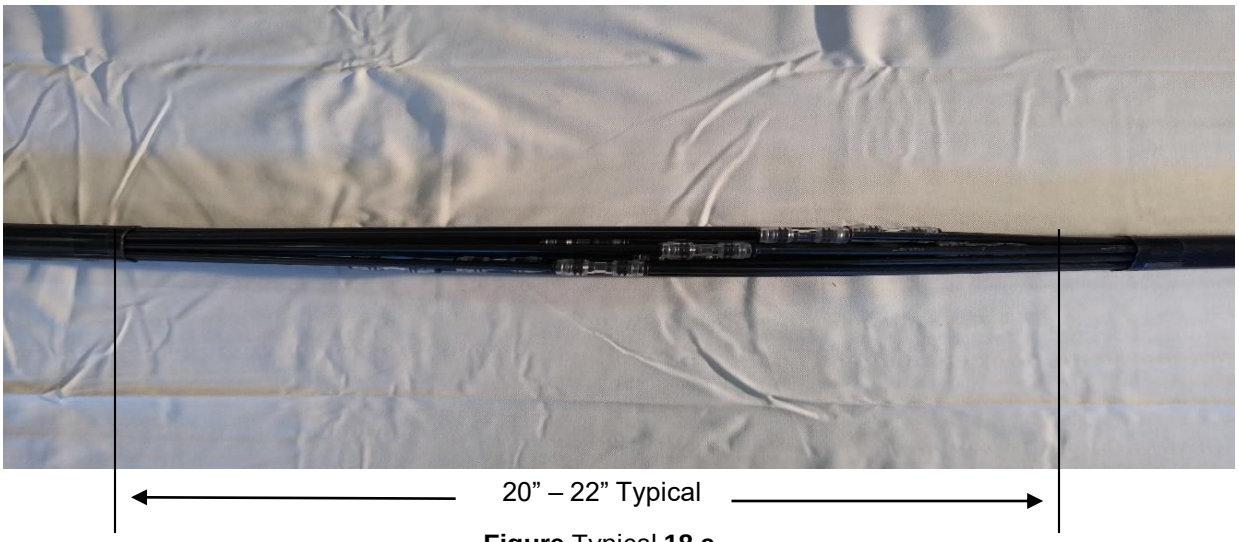


Figure Typical **18 a.**
Preferred In-Line Splice for 12-Tube Cable Example

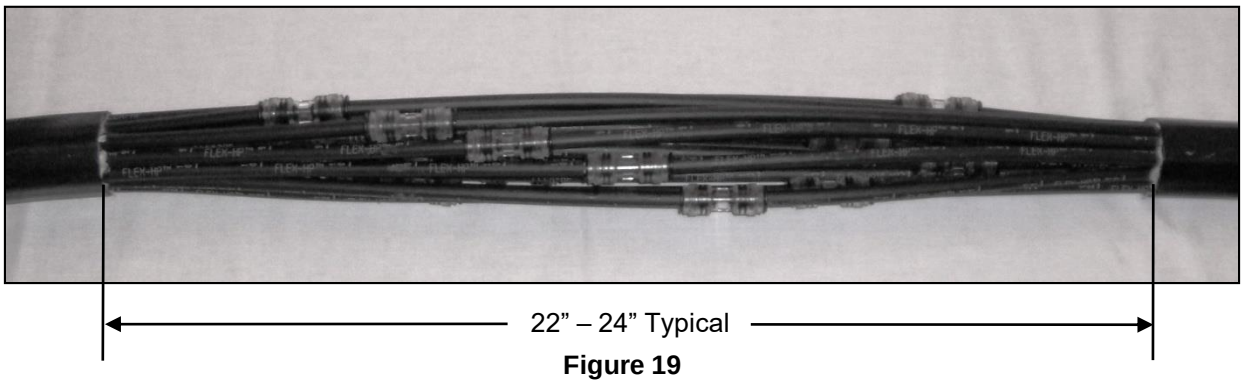


Figure 19
Preferred In-Line Splice for 19-Tube Cable Example

Preferred In-Line Splice for 24-Tube Cable Example not shown. Very similar to the 19 shown above, Note : Spice for 24 tube cable will be approximately 35 -36 inches long from sheath to sheath be mindful of TDU dimensions

13.0 "Unique" Tube Coupling Stagger Arrangement

13.1 The "Unique" Tube Coupling Stagger Arrangement is required when making an in-line splice used with a Tube Cable Splice Kit or when the in-line splice will be installed inside a Splice Case. Refer to SRP SP-F04-015 and SRP SP-F04-016 for further details.

13.2 An additional advantage of this arrangement is that its overall length is shorter than a Preferred In-Line Splice length. This feature makes it especially useful if the interior space of a TDU will not accommodate the longer Preferred In-Line Splice length.

Note: *Only a 7-tube cable is shown / described. Procedure for a 12 or 19 tube cable is similar. If 24 tube cable is to be used be mindful of TDU dimension. TC24 unique splice is approximately 35-36 inches from sheath to sheath.*

13.3 After determining available Strip Length and preparing both tube cable ends per normal procedures, perform the following steps.

13.4 On first tube cable, locate Tube 1. Measure 4" in from stripped end of tube cable jacket and mark Tube 1. Use Tubing Cutter to cut Tube 1 at this mark. **See Fig. 20.**

13.5 Locate Tube 2 on first tube cable. Measure 1-1/8" from the end of previous cut tube (Tube 1) and mark Tube 2. Use Tubing Cutter to cut Tube 2 at this mark. **Refer to Fig. 20.**

13.6 Repeat above step for all remaining tubes in ascending tube number order.

13.7 On second tube cable, locate Tube 7. Measure 4" in from stripped end of tube cable jacket and mark Tube 7. Use Tubing Cutter to cut Tube 7 at this mark.

13.8 Locate Tube 6. Measure 1-1/8" from the end of previous cut tube (Tube 7) and mark Tube 6. Use Tubing Cutter to cut Tube 6 at this mark.

13.9 Repeat above step for remaining tubes in descending tube number order.

13.10 Choose one tube cable and install a Tube Coupling on each tube. Be sure each tube is pushed all the way into its coupling and fully and firmly seated. **See Fig. 21.**

13.11 Connect tube cable ends together by first coupling tube with highest number to its mate. Continue coupling tubes in descending numerical sequence. Be sure each tube is pushed all the way into its coupling and fully and firmly seated. **See Fig. 22. (See Fig. 23 and Fig. 24 for examples.)**

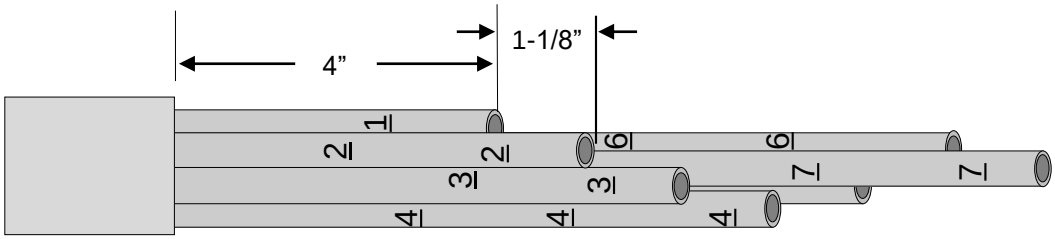


Figure 20
Cut First Tube Cable Tubes in Ascending Order; Tube 1-7 or Tube 1-19
Cut Second Tube Cable Tubes in Descending Order; Tube 7-1 or Tube 19-1

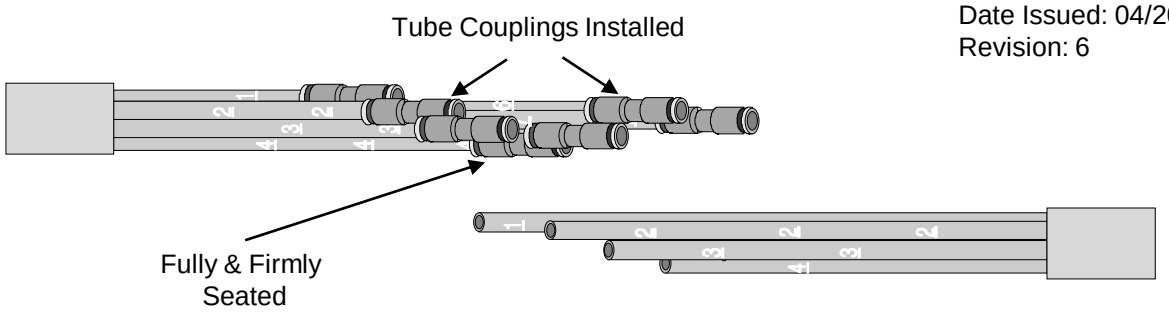


Figure 21
All Tube Couplings Installed on One Tube Cable

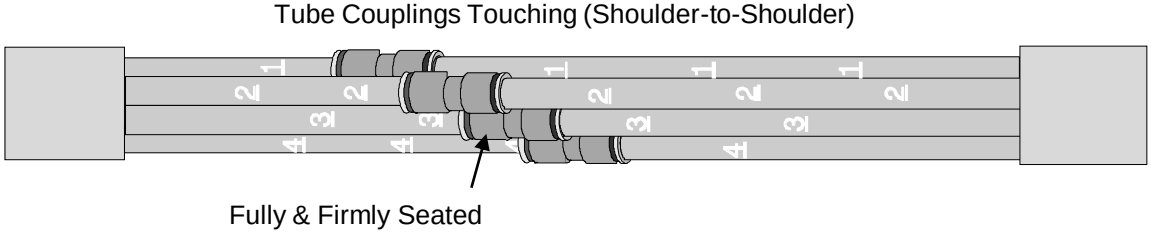


Figure 22
All Tubes Coupled in Proper Stagger Arrangement

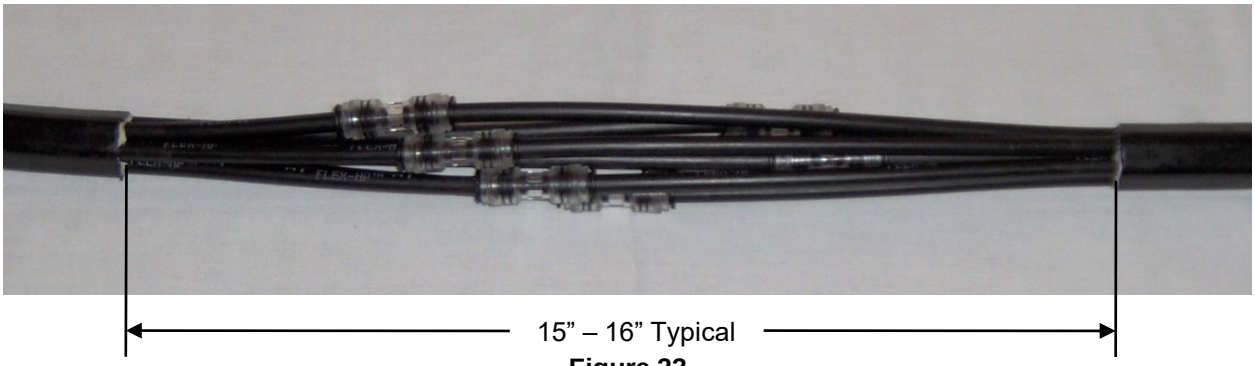


Figure 23
“Unique” Stagger Arrangement for 7-Tube Cable Example

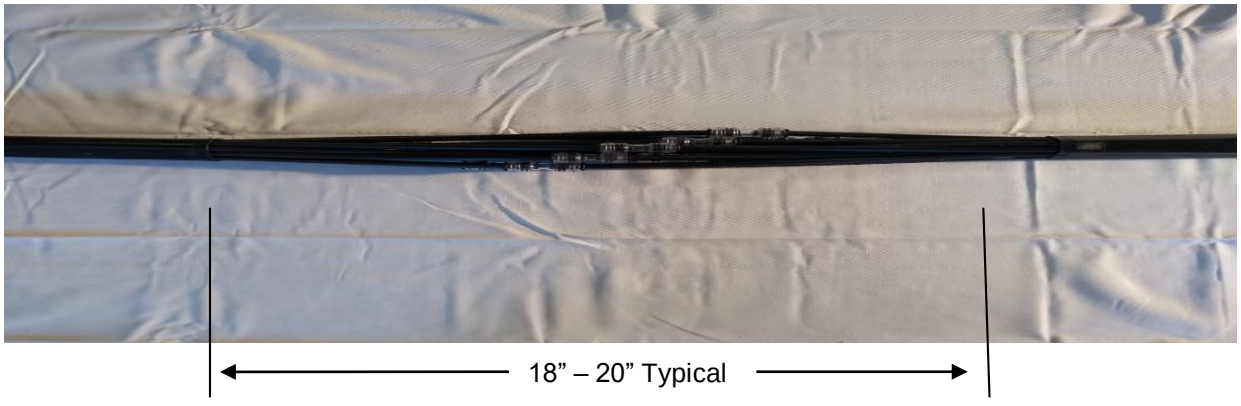


Figure 23.a
“Unique” Stagger Arrangement for 12-Tube Cable Example. A “Unique” stagger can be done on a 24 tube cable (not shown) , note the splice will be approximately 35-36 inches from sheath to sheath. Be mindful of TDU dimensions.

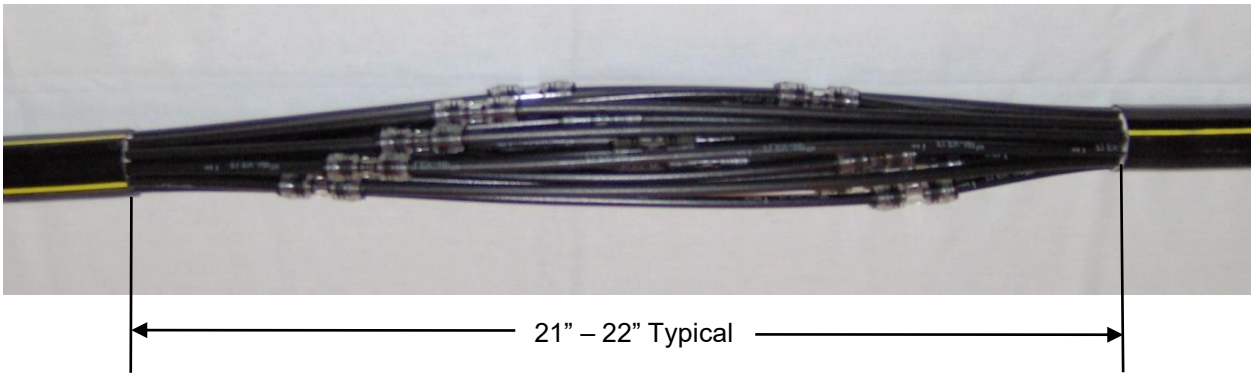
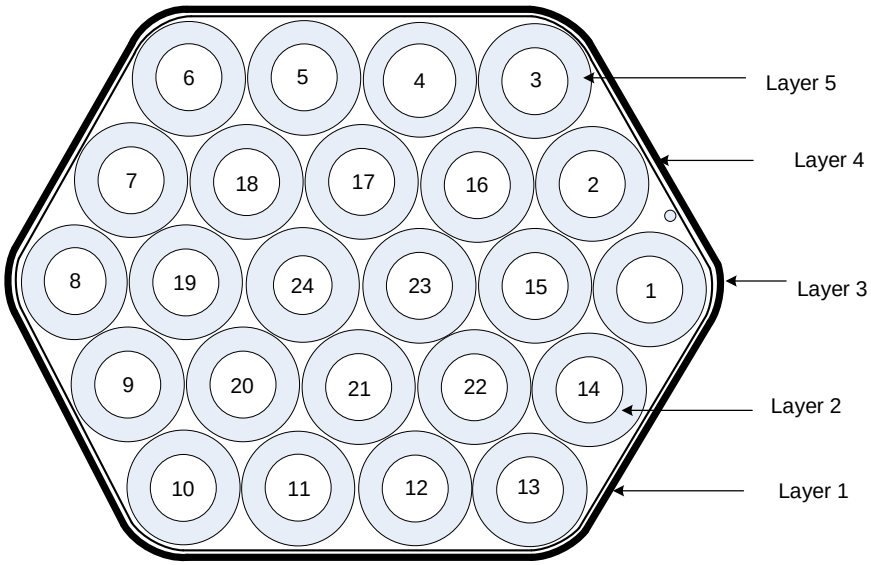


Figure 24
“Unique” Stagger Arrangement for 19-Tube Cable Example

“Unique” Stagger Arrangement for 24-Tube (not shown). Can be done on a 24 tube cable, ***Note:*** The splice will be approximately 35 - 36 inches form sheath to sheath, be mindful of TDU dimensions.

Alternative splice Arrangement for use with DE09SPC and DE12SPC “Fan Layer” confirm tube cable orientation, and directional Arrows on print string located on outer jacket. The 24 tube construction has 5 layers starting at the bottom Layer (1) has tubes 10-13 , Layer (2) has 9,20,21,22,14. Layer (3) has tubes 8,19,24,23,15,1. Layer (4) has 7,18,17,16,2. Layer (5) has 6,5,4,3. **As see in figure 24a.**



24-Tube
Dielectric OSP Cable TC24TOX
Figure 24a.

Figure 24b.

Break layers out in to groups , 1-5 using tape or rubber band come in handy, this helps keep thinks organized while getting ready for cutting tubes to fit. Above. The other cable using one coupler. This is an example of doing a TC24 to another TC24 Shown in Figure 24c.

Figure 24c.

Figure 24c shown above has the left side cable has be cut in to a “Fan Layer” configuration and right cable has been spliced in direct. Matching Layer to Layer.

Figure 24d.

Figure 24d. Above shows tubes cut into a “fan layer” configuration and has couplers installed on left side , and also right side has been cut into “fan layers” note layer one on the bottom is connected straight through and is center of the dimension of the DE09SPC splice case.

Figure 24e.

Figure 24e shown above has both left side cable and right side cable has been cut in to a Fan / Layer configuration and TC01TCX clear tube installed and used as jumpers between the two groups of layers, this adds clarity and can easily see tubes in the center and also fiber bundle in tubes.

14.0 Odd - Even Tube Coupling Arrangement

14.1 The Odd - Even Tube Coupling Arrangement is an excellent solution if space inside a TDU is extremely limited to accomplish an in-line tube cable splice.

14.2 The Odd - Even Arrangement locates the center Tube Coupling (Tube 7 or Tube 19 or 23 24) in the middle of the splice. Odd-numbered Tube Couplings are located on one side of the center Tube Coupling and even-numbered Tube Couplings are located on the other side.

14.2.1 Advantages – Good tube coupling organization and shortest overall splice length.

14.2.2 Disadvantages – Somewhat larger diameter may limit the number of other in-line splices that could be installed within a given TDU interior.

Note: *The Odd - Even Tube Coupling Arrangement is* ***not*** *to be used with a Tube Cable Splice Kit. The "Unique" Tube Coupling Stagger Arrangement described in SRP SP-F04-016 is the* ***required*** *solution in this case. TC24xxx excluded. May use DExxSPC with "Fan Layer" splice configuration .*

15.0 Odd - Even Splice for 7-Tube Cable

15.1 After determining available Strip Length and preparing both tube cable ends per normal procedures, perform the following steps.

15.2 Chose one tube cable. Locate, measure, and mark its Tube 7 at one half the Strip Length dimension recorded earlier. **See Fig. 25.**

15.3 Use Tubing Cutter and cut Tube 7 with a straight, clean cut.

15.4 Install Tube Coupling on Tube 7. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

15.5 Locate and lay Tube 7 of other tube cable next to installed Tube Coupling. Mark second Tube 7 to coincide with center point of Tube Coupling.

15.6 Use Tubing Cutter and cut second Tube 7 with a straight, clean cut.

15.7 Install second Tube 7 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

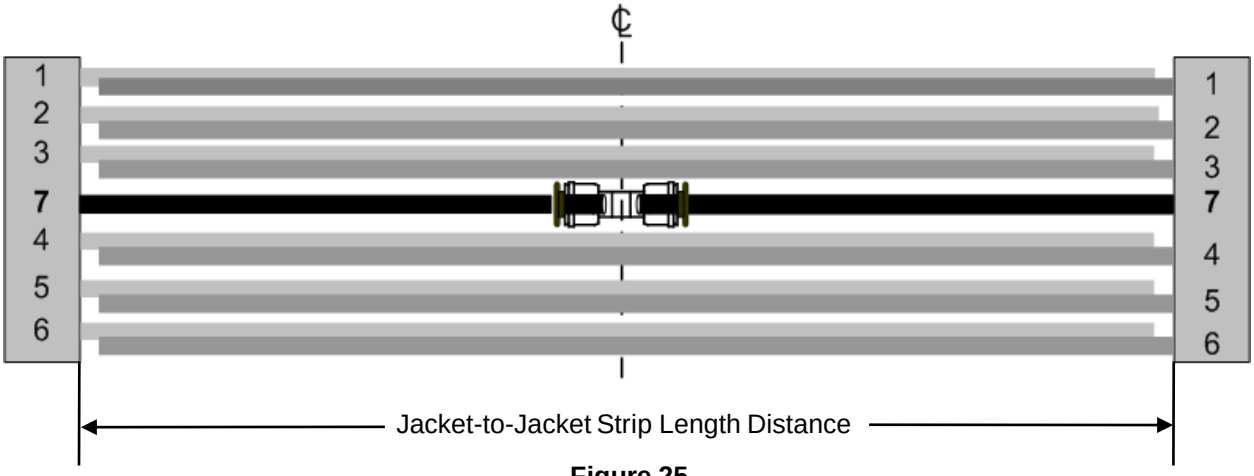


Figure 25
Tube 7 Coupling Installed in Center of Splice

15.8 Locate and lay Tube 1 of first tube cable next to installed Tube 7 Coupling. **See Fig. 26.**

15.9 Place a Tube Coupling on Tube 1 of first tube cable and adjust its position until there is about 1/4"- 3/8" space between its end and the end of installed Tube 7 Coupling.

15.10 Mark Tube 1 to coincide with the center point of the Tube Coupling.

15.11 Use Tubing Cutter and cut Tube 1 with a straight, clean cut.

15.12 Install Tube Coupling on Tube 1. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

15.13 Locate and lay Tube 1 of other tube cable next to installed Tube 1 Coupling. Mark second Tube 1 to coincide with center point of installed Tube 1 Coupling.

15.14 Use Tubing Cutter and cut second Tube 1 with a straight, clean cut.

15.15 Install second Tube 1 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

15.16 Repeat this procedure for Tubes 3 and 5 and for Tubes 2, 4, and 6 on the other side of Tube 7 Coupling. The "key" is to start in the middle and work toward the ends. **See Fig. 26.**

15.17 After all tubes are coupled, make final adjustments to tube and tube cable positions and secure in place to complete the installation. **See Fig. 30 for an example.**

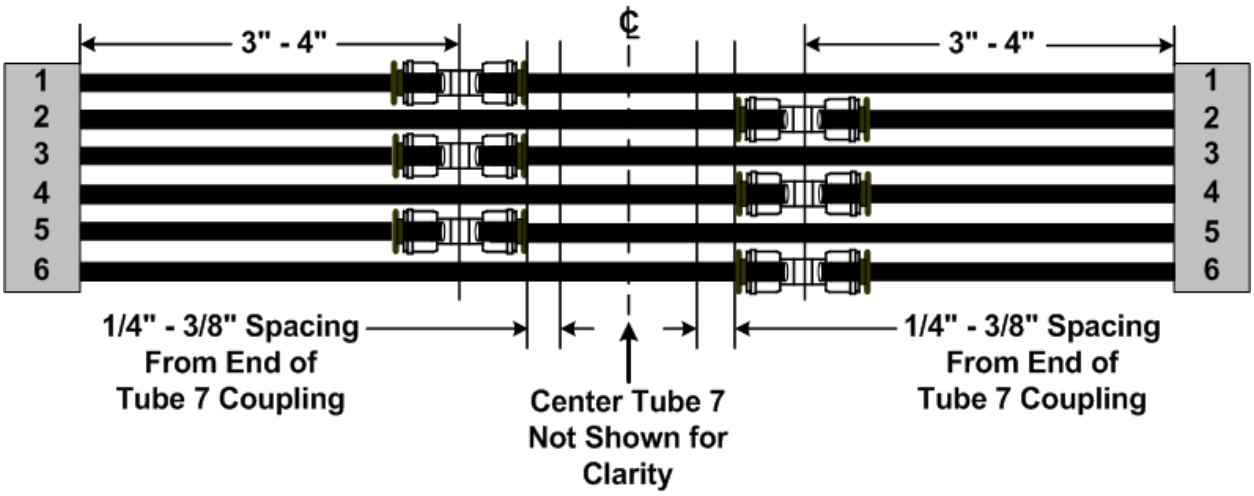


Figure 26
Odd-Numbered Tube Couplings to One Side of Center Tube 7 Coupling
Even-Numbered Tube Couplings to Other Side of Center Tube 7 Coupling

16.0 Odd - Even Splice for 19-Tube Cable

16.1 After determining available Strip Length and preparing both tube cable ends per normal procedures, perform the following steps.

16.2 Chose one tube cable. Locate, measure, and mark its Tube 19 at one half the Strip Length dimension recorded earlier. **See Fig. 27.**

16.3 Use Tubing Cutter and cut Tube 19 with a straight, clean cut.

16.4 Install Tube Coupling on Tube 19. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

16.5 Locate and lay Tube 19 of other tube cable next to installed Tube Coupling. Mark second Tube 19 to coincide with center point of Tube Coupling.

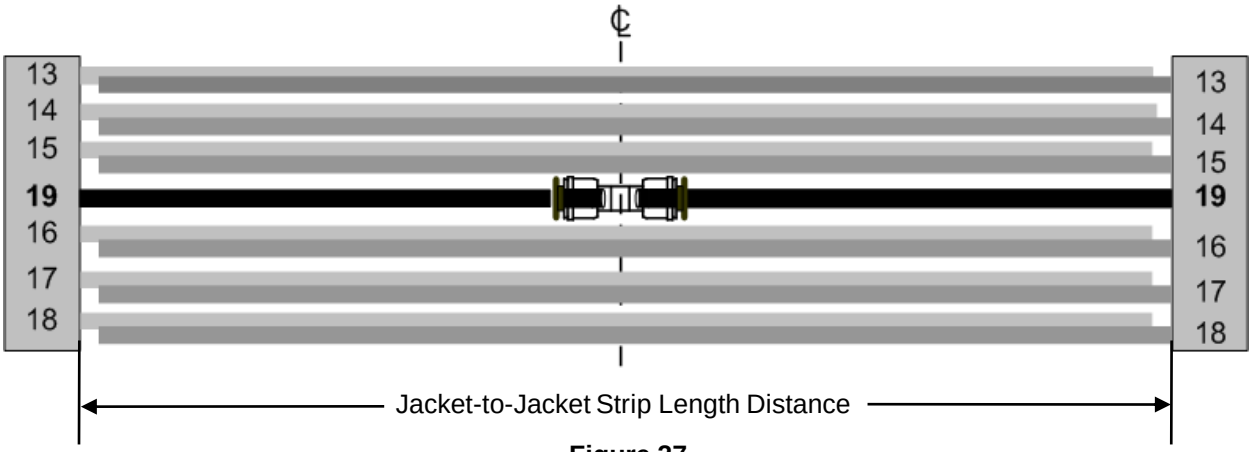


Figure 27
Tube 19 Coupling Installed in Center of Splice

16.6 Use Tubing Cutter and cut second Tube 19 with a straight, clean cut.

16.7 Install second Tube 19 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

16.8 Locate and lay Inner Ring Tube 13 of first tube cable next to installed Tube 19 Coupling. **See Fig. 28.**

16.9 Place a Tube Coupling on Tube 13 of first tube cable and adjust its position until there is about 1/4”- 3/8” space between its end and the end of installed Tube 19 Coupling.

16.10 Mark Tube 13 to coincide with the center point of the Tube Coupling.

16.11 Use Tubing Cutter and cut Tube 13 with a straight, clean cut.

16.12 Install Tube Coupling on Tube 13. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

16.13 Locate and lay Inner Ring Tube 13 of other tube cable next to installed Tube 13 Coupling. Mark second Tube 13 to coincide with center point of installed Tube 13 Coupling.

16.14 Use Tubing Cutter and cut second Tube 13 with a straight, clean cut.

16.15 Install second Tube 13 into Tube Coupling. Be sure tube is pushed all the way into the coupling and fully and firmly seated.

16.16 Repeat this procedure for Inner Ring Tubes 15 and 17 on one side of Tube 19 Coupling and for Inner Ring Tubes 14, 16, and 18 on the other side of Tube 19 Coupling. **Refer to Fig. 28.**

16.17 Repeat this procedure for Outer Ring Tubes 1, 3, 5, 7, 9, and 11 and for Outer Ring Tubes 2, 4, 6, 8, 10, and 12. **See Fig. 30.**

16.18 After all tubes are coupled, make final adjustments to tube and tube cable positions and secure in place to complete the installation. **(See Fig. 31 for an example.)**

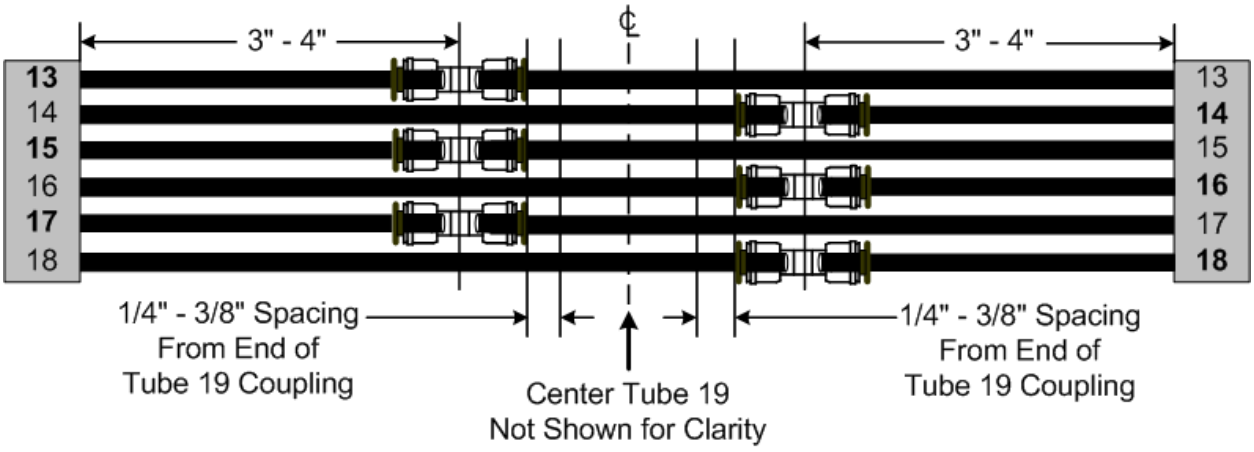


Figure 28

Odd-Numbered Inner Ring Tube Couplings to One Side of Center Tube 19 Coupling

Even- Numbered Inner Ring Tube Couplings to Other Side of Center Tube 19 Coupling

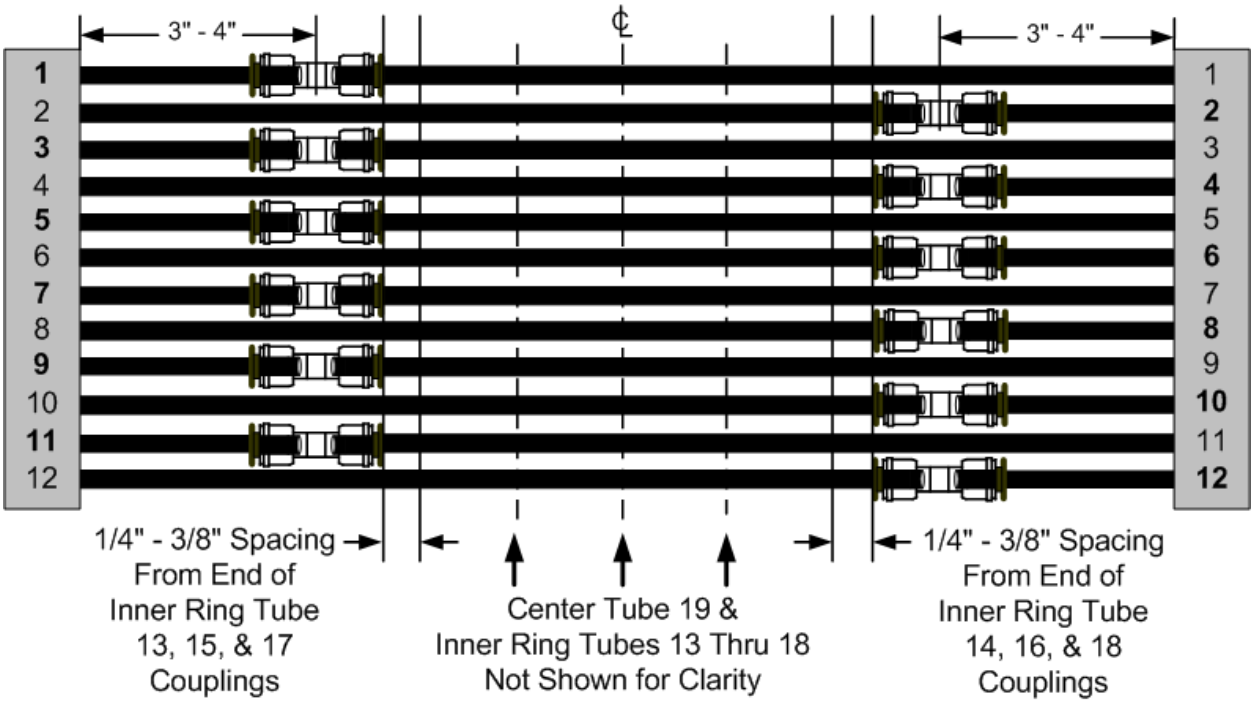


Figure 29

Odd-Numbered Outer Ring Tube Couplings to One Side of Odd Inner Ring Tube Couplings

Even- Numbered Outer Ring Tube Couplings to Other Side of Inner Ring Tube Couplings

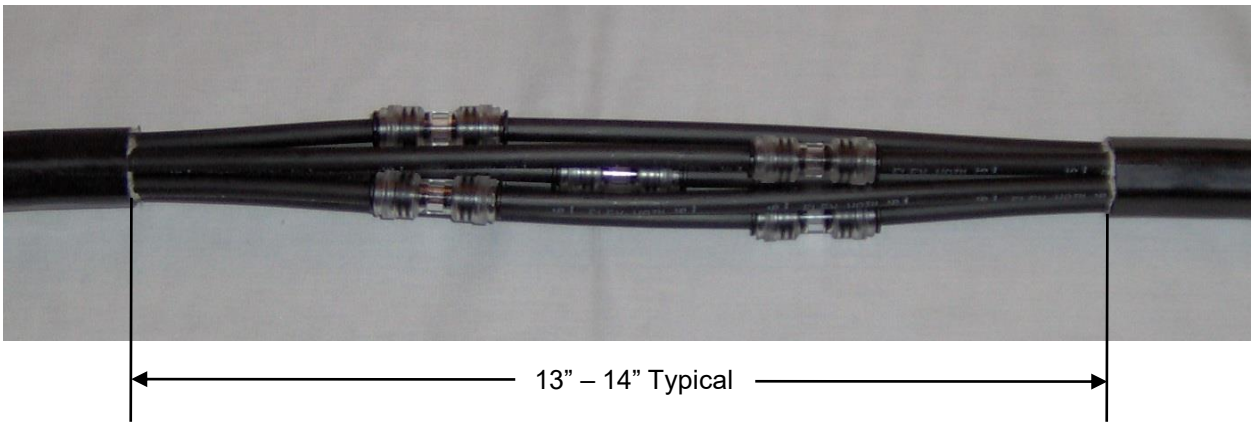


Figure 30
Odd – Even Tube Coupling Arrangement for 7-Tube Cable Example

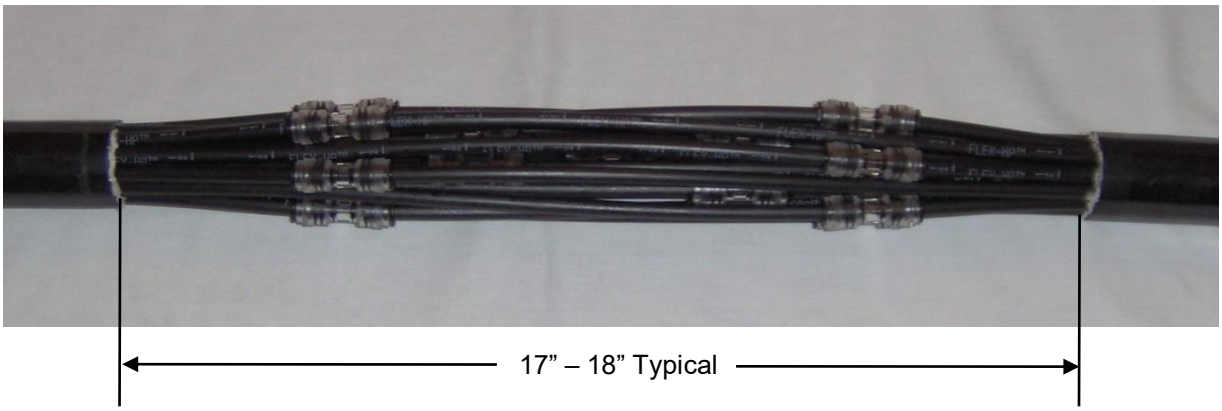


Figure 31
Odd – Even Tube Coupling Arrangement for 19-Tube Cable Example

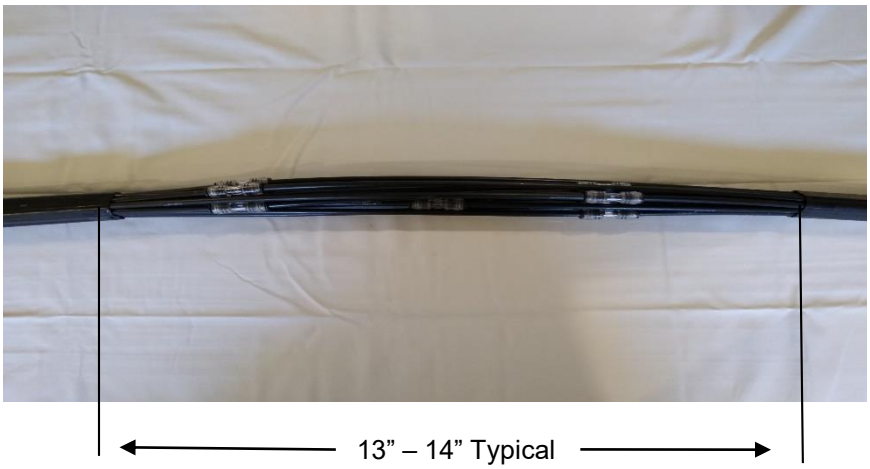


Figure 30
Odd – Even Tube Coupling Arrangement for 12-Tube Cable Example

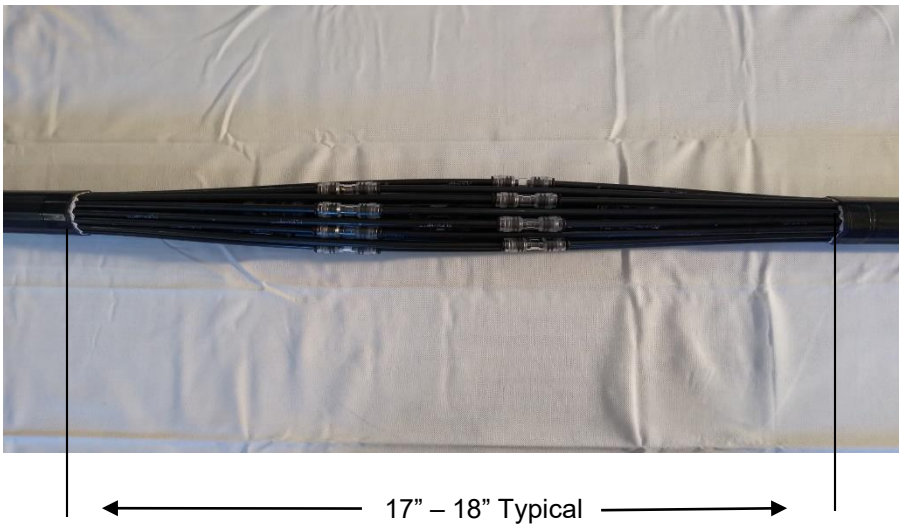


Figure 31
Odd – Even Tube Coupling Arrangement for 24-Tube Cable Example

17.0 All-in-a-Row Tube Coupling Arrangement

17.1 A staggered tube coupling splice arrangement is preferred but on-site conditions often dictate the coupling arrangement that must be used. An alternative to a staggered arrangement is to locate all the tube couplings in a row and centered within the splice length.

17.1.1 Advantages – Easy to make and can sometimes result in a shorter overall splice length.

17.1.2 Disadvantage – Bulky tube coupling arrangement can reduce / restrict the number of other tube cable splices that can be installed inside a TDU.

17.1.3 Disadvantage – Inner ring Tube Couplings often inaccessible for future connect / disconnect work.

17.2 The bulky arrangement and inaccessibility issues make the All-in-a-Row Tube Coupling Arrangement the least desirable splicing method. It should, therefore, be avoided whenever possible.

17.3 After determining available Strip Length and preparing both tube cable ends per normal procedures, perform the following steps.

17.4 For a 7-Tube Cable, locate and install a Tube Coupling on Tube 7 in the center of the splice. Locate and install remaining Tube Couplings in-line with Tube 7 coupling. **See Fig. 32 and Fig. 33.**

17.5 For a 19-Tube Cable, locate and install a Tube Coupling on Tube 19 in the center of the splice. Locate and install remaining Tube Couplings in-line with Tube 19 coupling.

17.6 After all tubes are coupled, make final adjustments to tube and tube cable positions and secure in place to complete the installation. **See Fig. 34 and Fig. 35 for examples.**

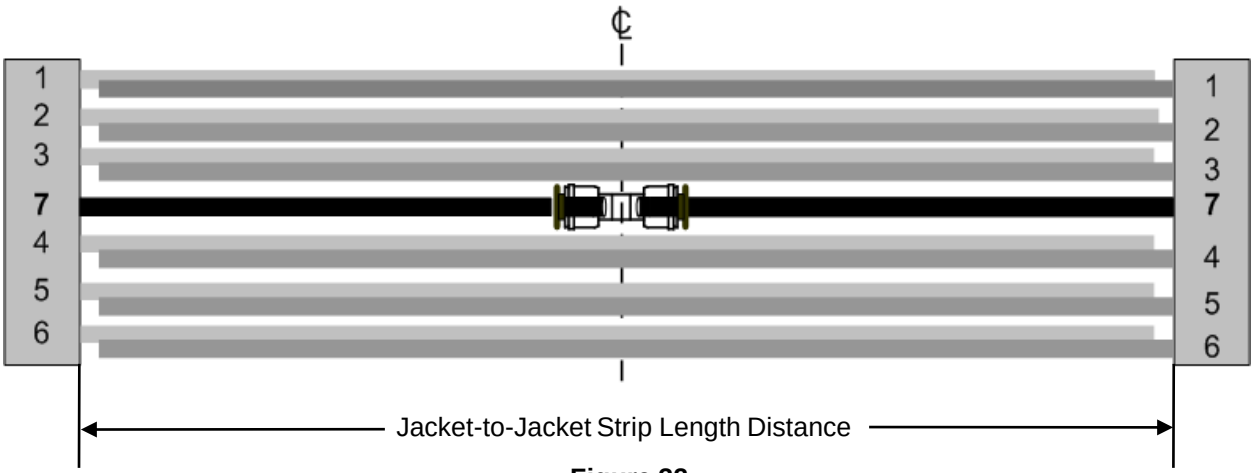


Figure 32
Tube 7 Coupling Installed in Center of Splice

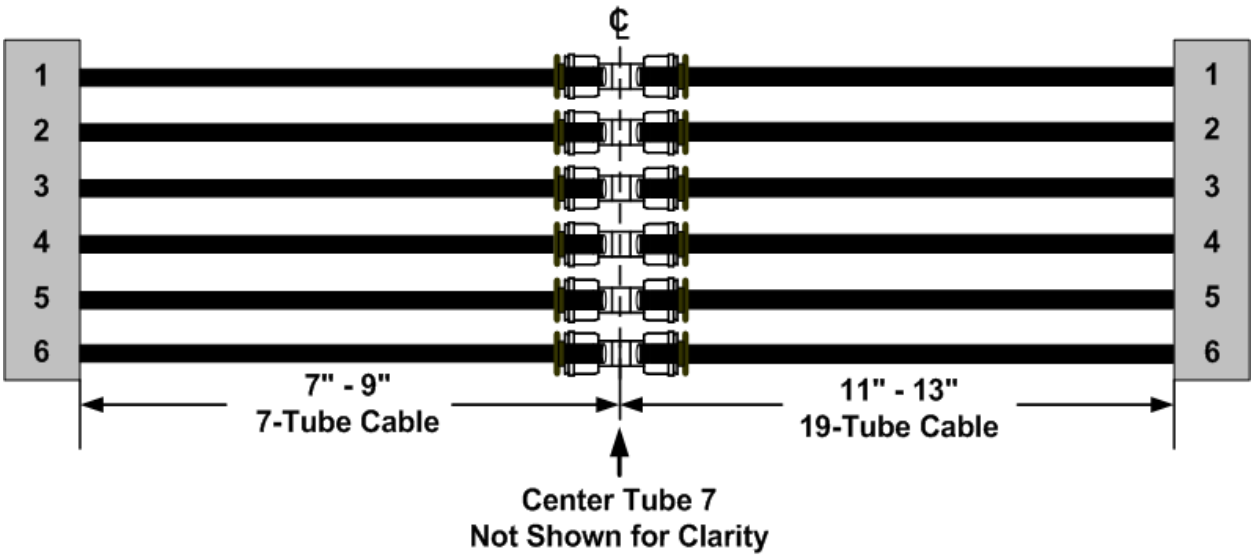


Figure 33
All-in-a-Row Tube Coupling Arrangement (19-Tube Cable Arrangement Similar)

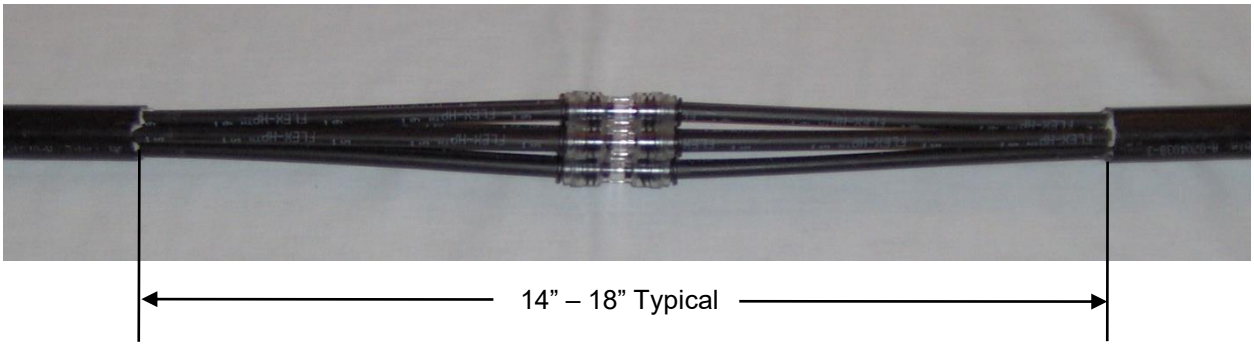


Figure 33
All-in-a-Row Tube Coupling Arrangement for 7-Tube Cable Example

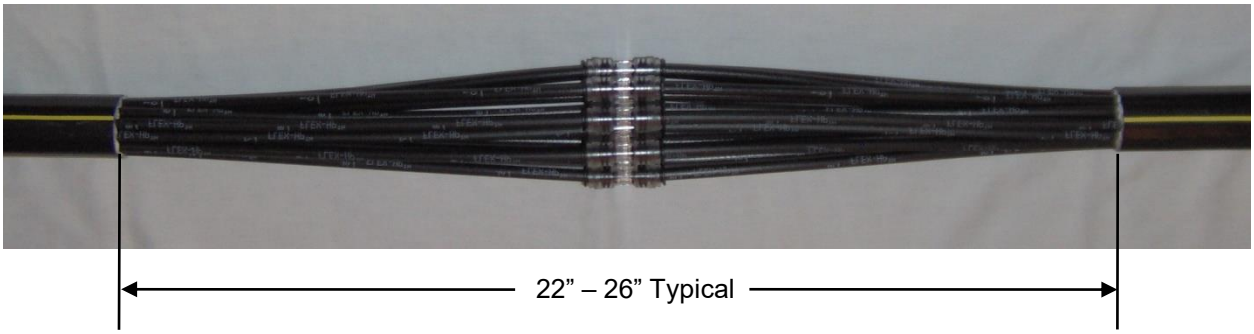


Figure 34
All-in-a-Row Tube Coupling Arrangement for 19-Tube Cable Example

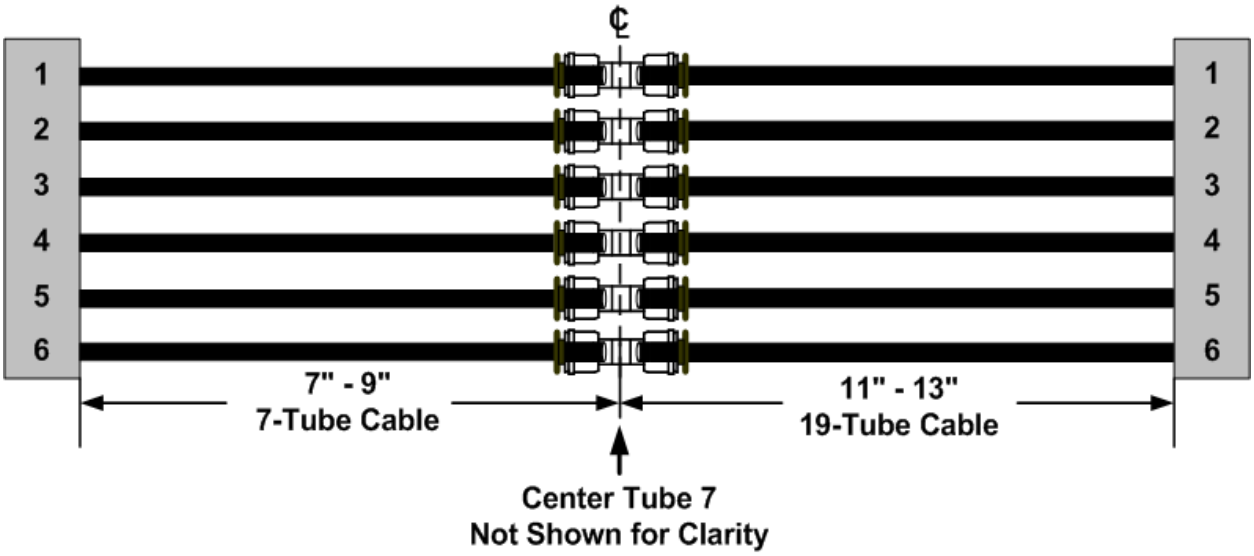


Figure 33

All-in-a-Row Tube Coupling Arrangement (19 , 12 and 24 Tube Cable Arrangement all Similar)

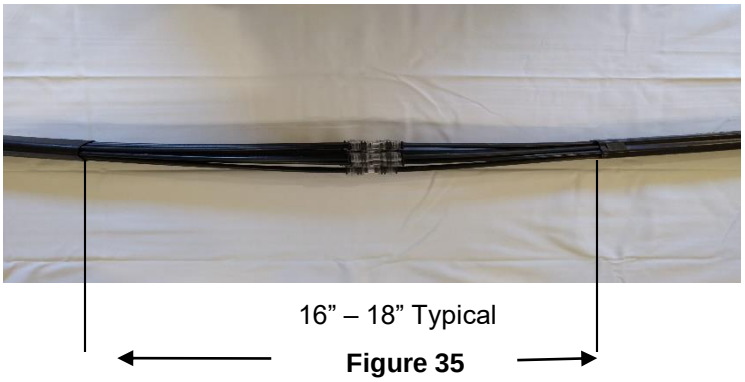


Figure 35

All-in-a-Row Tube Coupling Arrangement for 12-Tube Cable Example

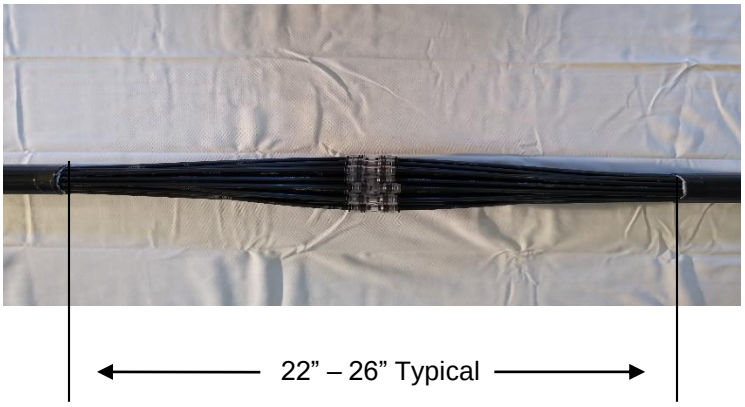


Figure 36

All-in-a-Row Tube Coupling Arrangement for 24-Tube Cable Example