



PRT-ES Tubing Installation (ZT03-98-001)

Background

When a heat shrinkable jacket is applied over a cable the jacket creates a secondary protective barrier that provides additional mechanical and electrical protection. However, under extreme environmental conditions moisture and contaminants can wick between this secondary jacket and the cable insulation. The resulting exposure can lead to corrosion of any exposed conductors and potentially cause circuit failure. Using Zippertubing's PRT-ES product is an effective way to eliminate this problem because it eliminates any voids or gaps between the secondary jacket and the cable jacket. This sealing process is commonly referred to as "Water Blocking" and the most reliable way to achieve this when using heat shrinkable parts is to apply a hot melt adhesive under the tubing material prior to shrinking. The hot melt adhesive melts and flows during the heating process and the constricting tubing drives the molten sealant into any voids or gaps. Once these voids have been filled there is no remaining air space between the two layers. The result is that no pressure differential exists between the inside and outside of the cable assembly and as a result changes in external atmospheric pressure or water pressure no longer causes moisture to migrate into the cable repair area.

The Problem

Photograph number one illustrates a classic example of an electrical wire that has suffered insulation damage due to harness chaffing. The damage level is severe enough to cause a possible short circuit condition and at the very least conductor corrosion and failure if not repaired. However, the conductor is still intact and cutting the wire in two to install a wire splice is typically undesirable as this type of repair may affect the wire resistance and would create a very stiff area that may lead to future failure. The PRT-ES product was specifically developed to create a quick, reliable and flexible repair that is virtually as good as the original wire insulation as long as the primary conductor has not been damaged. PRT-ES is not a splicing device! Never use PRT-ES if the primary conductor has been severely damaged. The advantage of using PRT-ES on minor insulation damage is that it can be installed quickly, with minimal harness and connector disassembly and is far more rugged and reliable than a temporary tape wrap repair. A PRT-ES repaired wire can provide many years of service assuming it's installed correctly and is not exposed to environmental parameters beyond its design limits.



Photo 1: Typical wire insulation damage

Installation

- 1) Measure the outside diameter of the damaged wire or cable at a location away from the defect using a caliper or micrometer. Use Table 1 to find the measured cable diameter in column 1. Select the corresponding PRT-ES repair tubing part number and size from column 2.
- 2) Use a razor knife to trim away any protruding pieces of wire or cable insulation in the defect area. Clean the repair area of all debris and oil contamination using a mild solvent like Isopropyl Alcohol (IPA).
- 3) Cut the PRT-ES Tubing from the spool or roll using scissors. The cut length should long enough to cover the entire defect are and extend beyond it by 1/2 inch minimum on each end for cable diameters up through 3/4 inches. For cable diameters greater than 3/4 inch increase the extension to 1.0" minimum. Wrap the PRT-ES tubing around the damaged wire so the paper release liner faces the installer. Peel back a portion of the release liner (not all) and expose the adhesive. Position the non-adhesive edge of the tubing over the exposed adhesive section and align so all the adhesive is covered but no more. Never over-wrap the tubing leaving a loose flap of material at the overlap. Doing so could result in an undersized tubing condition and lead to the tubing tearing apart during the heating process. Begin bonding the tubing overlap edge to the adhesive. Avoid contacting the adhesive with your fingers as much as possible. Remove short sections of the release liner until the entire tubing length is sealed closed. Rub the overlap seam area firmly using your thumb to work out any wrinkles. Minor wrinkles will disappear when the tubing shrinks. (Photo 2).

Note: Do not be overly concerned about the size of the sealed tubing compared to the wire size. It will always appear extremely large.

Table 1. PRT-ES Sizing Chart ¹

Cable Diameter Inches (mm)	PRT-ES Size Use P/N: ZT03-04-010-(*)	Cable Diameter Inches (mm)	PRT-ES Size Use P/N: ZT03-04-010-(*)
.040 - .075 (1 - 2)	-01	0.88 – 0.99 (22 – 25)	-19
.076 - .125 (2 - 3.2)	-03	1.00 – 1.12 (25 – 29)	-21
0.126 – 0.174 (3.2 – 4.5)	-05	1.13 – 1.24 (29 – 32)	-23
0.175 – 0.249 (4.5 – 6.3)	-07	1.25 – 1.37 (32 – 35)	-25
0.25 – 0.37 (6.3 – 9.5)	-09	1.38 – 1.49 (35 – 38)	-27
0.38 – 0.49 (9.5 – 13)	-11	1.50 – 1.62 (38 – 41)	-29
0.50 – 0.62 (13 – 16)	-13	1.63 – 1.74 (41 – 44)	-31
0.63 – 0.74 (16 – 19)	-15	1.75 – 1.87 (44 – 48)	-33
0.75 – 0.87 (19 – 22)	-17		

¹ For PRT-ES Tubing installations on cable diameters greater than those shown in Table 1 please contact the Zippertubing Engineering Department for recommended materials and refer to Process document ZT07-98-003.

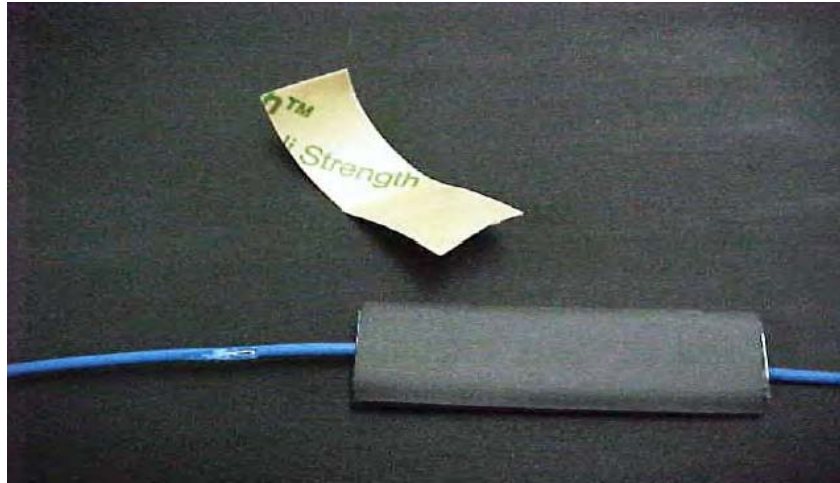


Photo 2: PRT-ES Tubing installed around damaged wire.

- 4) Center the closed PRT-ES tubing over the damaged area of the cable and rotate the tubing's overlap seam area so it covers the cable defect.
- 5) PRT-ES Tubing requires a hot air type of heat gun with a temperature setting of approximately 150-160°C to shrink the tubing and allow the Z-Block adhesive to flow. Always use a heat gun with a small reducer nozzle that will localize the heat stream (Photo 3). Never use a standard heat gun tubing reflector that is designed to spread the heat evenly around the tubing!

Note: You may shrink the tubing in place immediately after sealing.
The closure adhesive system has no cure time requirements.



Photo 3: Heat Gun reducer nozzle

- 6) Begin shrinking the PRT-ES tubing by directing the heat source at the

adhesive overlap area near the center of the tubing (Photo 3). Apply heat to the adhesive overlap area only! The overlap area will tend to curl up into a “U” shape as it is heated (Photo 4). Continue applying heat in short bursts to this area until the surrounding tubing begins to pull the “U” shape back down flat. Do not be afraid to apply extra heat to the overlap area, as it will take extra dwell time for the inside layer of the overlap to shrink. Do not be alarmed if the outer layer of the overlap flap tends to lift off the adhesive and curl back slightly during initial heat exposure. With continued heating this lifted area will generally lay back down on its own, if not, lightly tap the lifted edge as necessary with a wooden Popsicle stick? Never squeeze the PRT-ES when tapping the lifted lip down and always use caution when touching the tubing as it will be hot and sticky. Shrink the overlap seam area along the entire part length before making any attempt the shrink the remaining tubing.



Photo 4: Overlap seams curled up prior to full shrinkage.

The best technique is to slowly heat the entire overlap seam length and work from the center towards the ends. Too much heat, too quickly, in one location may cause the hot melt adhesive to expand unevenly and possibly rupture the overlap seam. Refer to the Troubleshooting section at the end of this document. The key to a successful installation is to “sneak up” on the tubing with the heat source. Do not be afraid to pull the heat source away from the tubing as necessary and let the tubing cool slightly if it appears that the overlap seam is being pulled apart. Once the overlap seam is fully shrunk you may find that most of the remaining tubing has also shrunk (especially on small size wires and cables).

- 7) After the overlap seam has fully shrunk begin applying heat to the remaining tubing to smooth out any wrinkles and eliminate cold spots. Once all the tubing has shrunk, apply heat over the entire tubing length and circumference in a smooth and even motion. Continue until the hot

melt adhesive begins to flow and ooze out from both ends of the tubing. The finished part should have a fillet of adhesive at each end (Photo 5).



Photo 5: PRT-ES Sleeve with fillets

- 8) Do not attempt to remove the hot melt adhesive fillet! Do not be alarmed if the adhesive fillets are uneven around the circumference of the wire or undesirable looking cosmetically. You can re-apply heat to the fillet area and dress the excess. In general, a fillet that is exposed over the entire end circumference of the repair sleeve is what is important and not the cosmetic look or how uniform the fillet itself is.

Note: Small diameter wire repairs may require a magnifying glass to see the adhesive fillet properly.

- 9) While the assembly is still slightly warm to the touch, use your thumb and rub the tubing overlap seam edge to remove any exposed closure adhesive. The excess adhesive will ball up ahead of your thumb. Discard.

Caution:

Never attempt to remove excess adhesive using solvents.

- 10) Allow the assembly to cool to room temperature before placing into service.

Troubleshooting

The most common problem likely to occur when installing PRT-ES tubing is a seam rupture. This condition is where the molted Z-Block hot melt tape breaks through a section of the overlap seam during installation (Photo 6).

Seam ruptures are most likely to occur during the learning phase of PRT-ES installation. Once the proper installation technique has been mastered this problem will disappear. Seam ruptures occur for two main reasons and both can be controlled by the installer.

- 1) **Sizing:** The PRT-ES tubing selected in Table 1 was too small for the cable diameter being repaired.
- 2) **Heating:** The installer applied too much heat, too quickly to the PRT-ES tubing.



Photo 6: Typical overlap seam rupture

If a rupture occurs, verify that incorrect sizing was not the cause? If the cable outside diameter is very close to the upper limit of a size range shown in Table 1, consider increasing the PRT-ES size to the next larger size. Correct as necessary and attempt a new installation. If sizing is not the cause of the failure, then adjust the heating technique by applying the heat more slowly and evenly. Review the “sneak up on it” technique described in step #5.

Seam ruptures are undesirable and should be avoided. Cable assemblies with a diameter of less than 1/2 inch or those with a seam rupture in the immediate area of the cable damage should have PRT-ES jacket removed and replaced. Cables diameters greater than 1/2 inch exhibiting a seam rupture that is away from the actual defect repair area may be reworked and still provide a good environmental seal.

Note: Prior to proceeding with a seam rupture rework, consult with in-house Engineering and Quality Assurance departments and obtain approval to proceed with a repair versus removing and replacing the tubing.

Repair Technique

If you experience a seam rupture and the hot melt adhesive is oozing out through the tubing overlap area, stop applying heat in that area and allow it to cool down. Adjust your heating technique as described above and finish

installing the assembly. Obtain approval to attempt a seam rupture repair. With the entire assembly at room temperature return to the seam rupture and re-heat the localized area until the hot melt adhesive is soft. Use the end of a Popsicle stick and gently work the raised tubing lip down as smooth as possible while it's hot. Use the radius end of the Popsicle stick and scrape away the excess adhesive in a direction parallel to the overlap split line. You may have to repeat this process several times to obtain a nice appearance. Allow the area to cool to room temperature.

A repaired seam rupture will never look quite as good cosmetically as the seam areas that were properly installed. However, that does not mean that a seam repair cannot be used. As long as there is a thin bead of the "Z-Block" hot melt adhesive present along the overlap split line in the area of the rupture you have a usable assembly. Because the entire jacket is sealed with the hot melt adhesive there is no way for the environment to find its way to the repaired defect area. The same condition would exist if the rupture were not repaired. However, repairing a rupture is desirable since it eliminates the raised lip condition (Photo 6) which could create a potential snag problem resulting in further damage.

Installer Note:

Using the PRT-ES method of wire and cable repair will generally eliminate a very large amount of cable harness disassembly, rework, reassembly and potential hardware damage. As a result, don't be in a big rush to complete the installation. Take a few extra minutes to plan the installation, heat the sleeve slowly and work the materials as necessary to insure a good first time repair. The extra time spent doing this will pale in comparison to the time required to perform a classic repair that involves connector disassembly.