Conducting Wire Termination Procedure

UNOLS 0.322" 3-conductor cable

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Attachments:

Cable specifications, UNOLS 0.322" cable

PMI grip installation procedure

1. Materials Required

1.1. Tools

- Medium-sized flat-blade screwdriver
- Crescent wrench
- Soldering Iron
- Side cutters
- Large, flat-ended wire cutters
- Needlenosed pliers
- Wire stripper
- PanaVise
- Multimeter
- Megger

1.2. Supplies

- Solder
- Tinner's Acid
- Scotchfil
- Scotch 33+ tape
- Wire Grip (PMI left-hand lay)
- Single-pin female pigtails (SeaCon RMA-FS with leads)- or other
- Crosby 1/2" wire clamp ("Crosby clip")
- Rags
- 1 inch thimble

2. Underwater Splice

2.1. CABLE PREPARATION

2.1.1. Cut off and log any badly rusted or kinked cable before starting the splice. Be sure to tape the cable at the point where it is to be cut.

2.1.2. Strip outer armor: At a point about 12-14 inches from the end, wrap a tape stopper around the cable. This will prevent the armor from unlaying beyond this point. One-at-a-time, unwind the outer armor strands from the end, back to near the tape stopper, and cut off short. Continue until all outer armor wires are cut off. Smooth down the cut-off ends of the armor wires, and tape until tight and smooth.

2.1.3. Strip back inner armor: The inner armor is now exposed. One-at-a-time, unwind all but 3 of the inner armor strands back to the tape, bend back sharply, and cut off at about 1 inch. Tape over the resulting "birdcage" until tight and smooth. You may need to wrap a wire tie around the bundle to keep the wires in place, and avoid exposing

sharp ends. The ends of the armor wires should be covered with enough tape so that sharp ends will not poke through the tape and damage any leads. The ends of the inner armor wires are bent back so that no sharp armor wires can poke through the inner jacket or insulators and short them to the armor.

2.1.4. Strip inner jacket/filler: There is no easy way to do this. In the construction of the UNOLS 0.322" cable, the three conductors are extruded through the black PVC inner jacket or filler. As a result, it is difficult to strip the jacket from the conductors. Generally, it is relatively easier to use a sharp knife or side cutters to score the jacket, then bend the inner bundle sharply until the PVC breaks around the wire. Then the cut off piece of jacket can be worked off the end of the bundle. It is usually impractical to remove more than 1/2" to 1" of the jacket at a time. At least 4 inches of jacket should be removed, exposing the three conductors. Take care not to deeply cut the insulation of the conductors. In the course of bending the bundle to remove the jacket, the insulation may become discolored (milky). This is normal, but does indicate a weakness in the insulation which must be taken care of in the dressing of the splice. When finished, the three long inner armor wires will remain wrapped around the inner jacketed bundle.

2.1.5. Prepare single-pin leads: Strip outer jacket (black neoprene) from the last 1.5-2.5 inches of the lead. This is best done by bending the lead sharply, then gently slicing across the jacket with a sharp knife. When the jacket is sliced all the way around, it can be pulled off the end. This will expose the inner insulator, which may be white neoprene (soft) or teflon (hard). The insulation can be stripped off with conventional wire strippers. Strip about 1 inch off the wire, and tin. The entire length to be stripped can be done at once with neoprene insulation. For the teflon insulation, only a small length (1/4 inch or so) can be done at a time.

2.2. SOLDER JOINTS

2.2.1. Solder leads to conductors: FOR CTD: Strip the insulation off of each conductor (about 1 inch), and tin each lead individually. Connect all three conductors together and solder a single pin lead to them. Any appropriate mechanical connection can be used, so long as a strong mechanical and electrical contact is made. If the conductor is somewhat corroded, it may be necessary to clean the copper wire with tinner's acid before tinning. To clean, tin the soldering iron, heat the copper wire, then drip acid onto the bare wire. The wire should shine up and start to wick solder from the iron. Finish tinning when clean. **FOR OTHER APPLICATIONS:** Depending on the application, it may be necessary to solder a multiple conductor harness directly to the wires.

2.2.2. Solder lead to armor: This will be the ground connection for the system. Clean the three armor wires (left long from step 3) with tinner's acid as above. Be sure that all three wires are clean for at least 4 inches from the end. Using any appropriate mechanical connection, connect the armor wires to the lead or wire harness. Solder the connection.

2.2.3. Check for shorts and continuity: Before completing the splice, it is wise to check for continuity from the end of the pigtails to the end of the sea cable. This is most easily done by jumpering one end of the cable, and checking for continuity between pins at the other end. To check for shorts, remove the jumper, and use the Megger to check for short between the conductor(s) and the armor. Resolve any problems with continuity and shorts before continuing.

2.3. UNDERWATER SPLICE:

2.3.1. Waterproof Splice: A waterproof splice is only required on the cable conductor lead(s). The armor (ground) lead does not require a waterproof splice. The armor is exposed to seawater for its entire length, so it makes no sense to dress it as a waterproof splice.

2.3.2. Inner Dressing: Cut off about 1 inch of Scotchfil from the roll, and remove the liner. Stretch the Scotchfil and wrap it around the solder joint. Continue the dressing at least 1 inch onto the conductor insulation, and onto the pigtail at least up onto the end of the outer jacket. This increases the length of the water path to the splice. When wrapping onto the conductor insulation, take care to wrap Scotchfil over any breaks or weak spots caused during the stripping process. continue wrapping Scotchfil in thin layers until the entire solder joint and adjacent areas are covered, and the total thickness of the dressing is at least twice the diameter of the wire bundle. Squeeze the termination to seat the dressing, and to ensure that no sharp ends can be felt through the Scotchfil. You may hear a popping sound as air bubbles in the wrap are purged - this is good. Air in the dressing will eventually admit water and cause a short to the sea. The wrapping should be tapered towards the ends to help with the next step. If in doubt, add more Scotchfil.

2.3.3. Outer Dressing: Since Scotchfil will flow under pressure, it must be stabilized by overwrapping. Using Scotch 33+ electrical tape, wrap at least two layers of tape over the Scotchfil dressing. Do not wrap the armor splice in with the Sctochfil splice - Scotchfil will flow and cause a short to the armor. Each wrap should overlap the previous by about 1/2 width. Start wrapping at about 3/4 inch from one end of the Scotchfil dressing, and wrap along the dressing to about 3/4 inch beyond the other end.

2.3.4. Final Splice Dressing: Wind the armor splice around the fully-dressed waterproof splice, and tape over all the components. Continue this taping for at least 6 inches up

the cable from the splice, and down onto the paired pigtail leads. This provides more mechanical stability and protection for the splice. If there are sharp wire ends in the armor solder joint or splice, these should be covered with tape until they can no longer pole through the splice and short the conductor. If in doubt, **add more tape**.

2.4. MECHANICAL TERMINATION

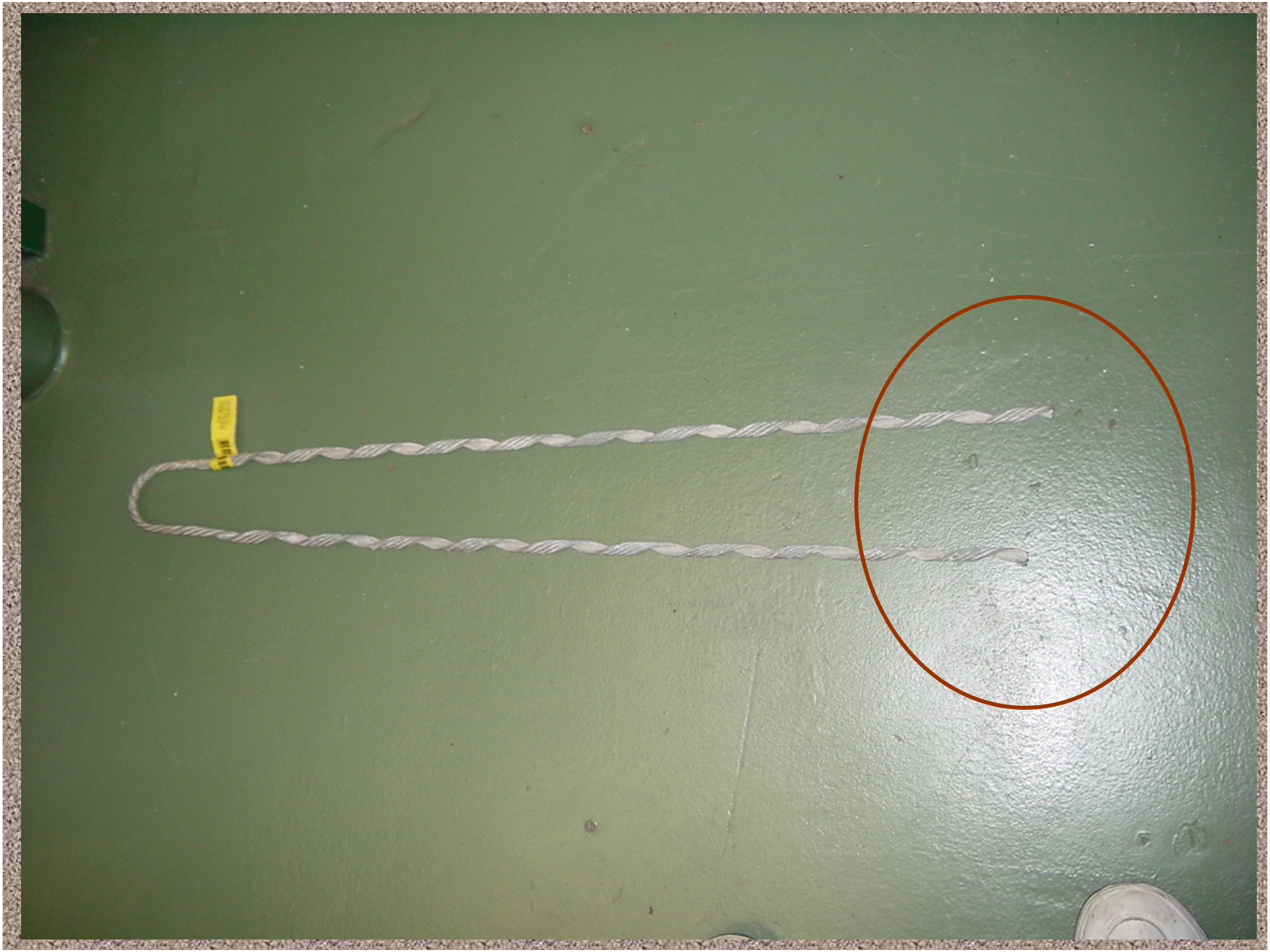
2.4.1. Install Cable Grip: For CTD - About 6 feet up the cable from the splice, begin installing the PMI cable grip per the attached instructions. **Be sure that the eye of the grip is towards the splice end of the cable.** Place the 1-inch thimble in the grip eye before installing. It is not particularly important whether the cable exits the grip inside or outside the eye loop, so long as the cable grip is wrapped onto the cable for its whole length. At the (non-loop) end of the grip, it may be necessary to use a screwdriver to lever the grip wires around onto the cable. When finished, wrap the end of the grip with tape to secure it. A cable tie or hose clamp can be used for this, but should be over-wrapped with tape to secure it in place. **For other applications:** Place the grip in a place appropriate to the application, keeping in mind that the splice should not be placed at any point of articulation (i.e., at a shackle or link). It is best if the fully armored cable runs through the attachment point. If this is not possible, protect the splice with garden hose or similar chafing gear.

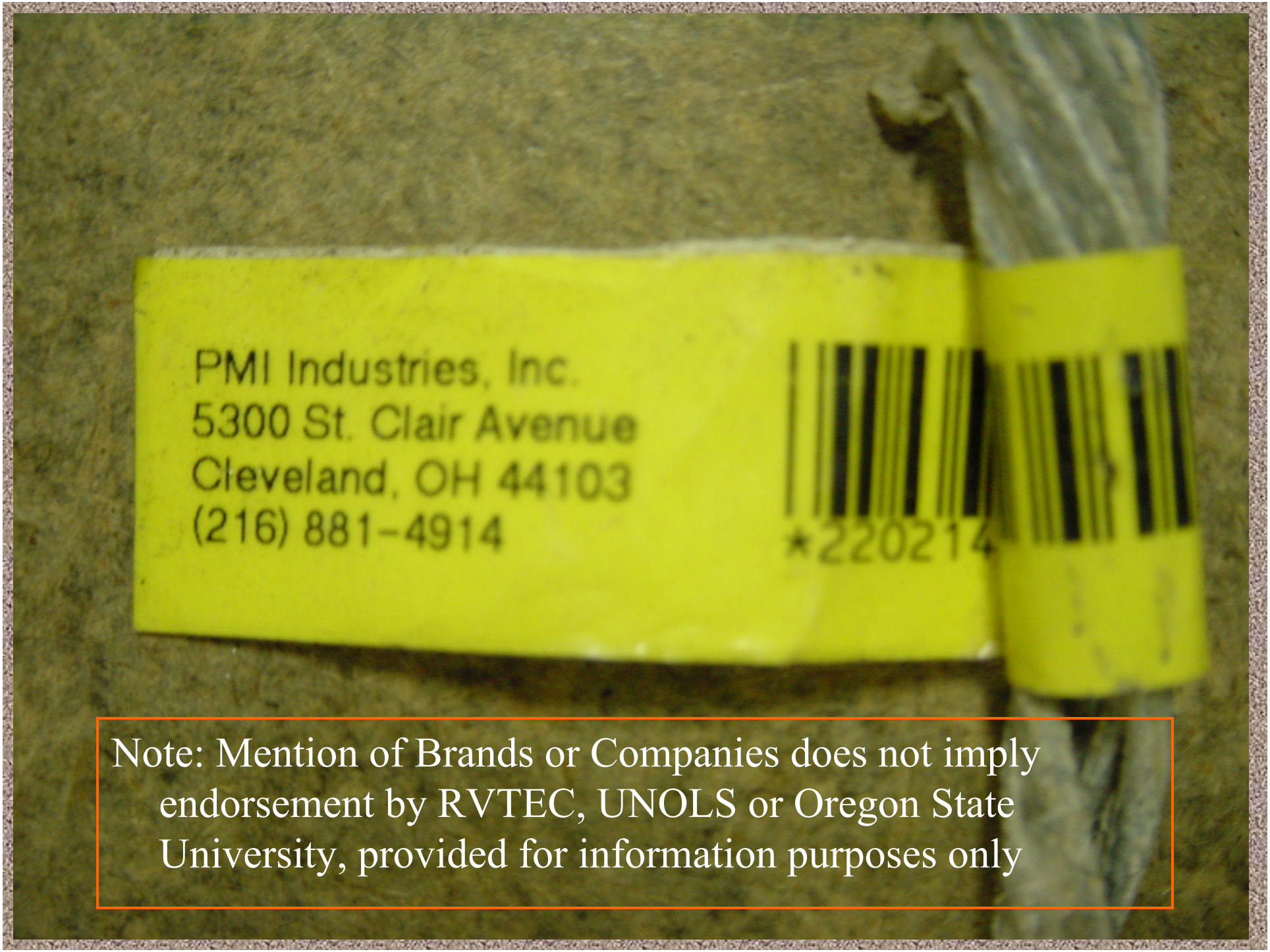
2.4.2. Install Crosby Clip: Place the 1/2" Crosby clip at the base of the eye, where the cable grip is fully wrapped around the cable. Snug the nuts, but do not fully tighten them, as this may damage the cable or conductors. [NOTE: certain clips may not tighten all the way, they may bottom out the threads on the U-bolt before tightening down fully on the cable grip - this is fine] Overwrap the nuts and grip securely with Scotch 33+ tape. The clip is placed to keep the grip from "unwinding" from the eye end under tension - the main failure mode for this type of grip. PMI grips rarely if ever slip off, they unwind from the eye. The nuts are taped so that they will not loosen and work off as the cable strums.

2.4.3. Strength: Generally, the PMI grip mechanical termination as outlined above is 90-100% as strong as the cable. On the UNOLS 0.322" cable, this means that the grip will fail at 9000-10000 lbs.

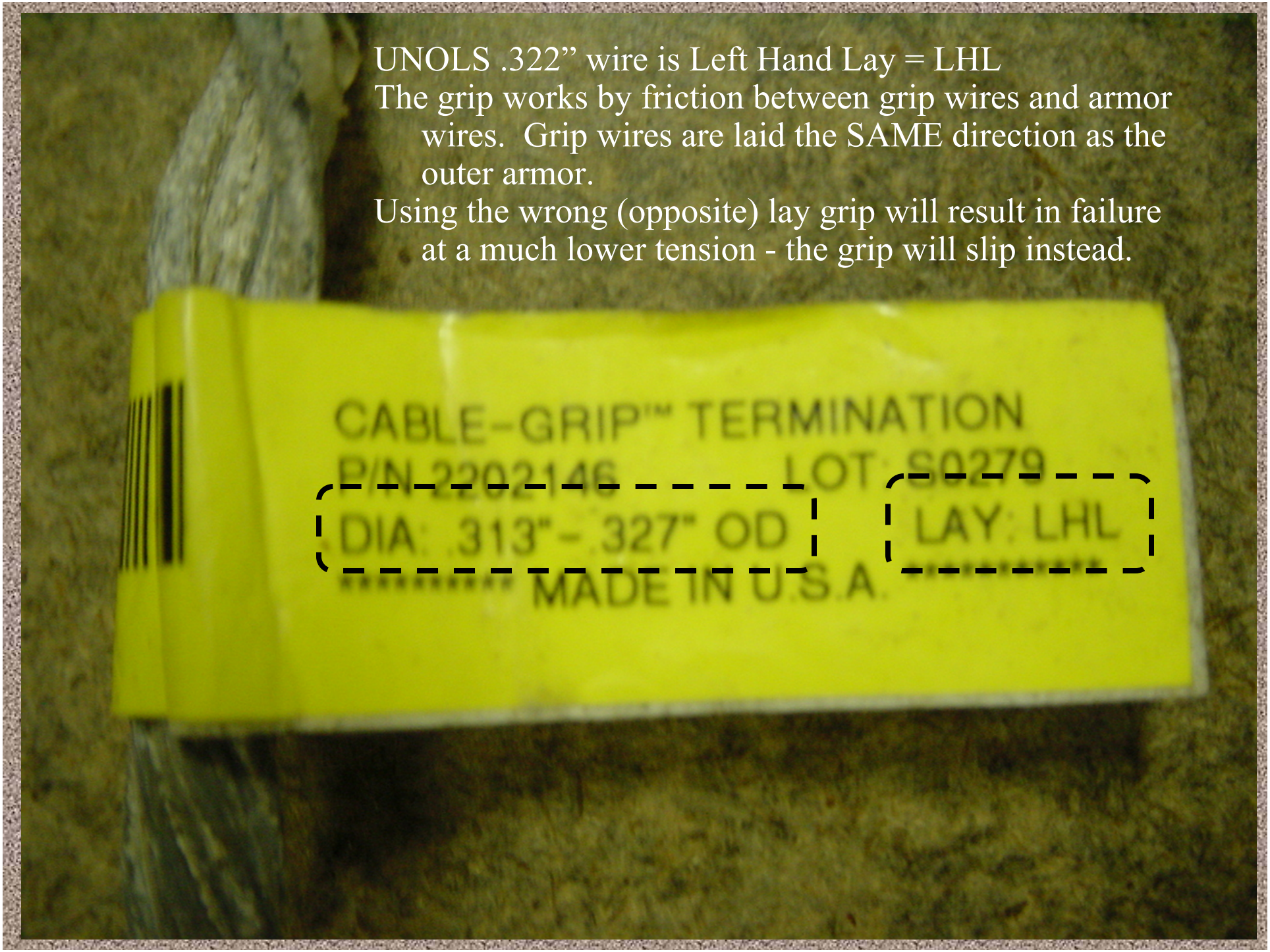
Tips and Tricks for PMI "finger grips" on EM cable

Marc Willis, Oregon State University RVTEC 2007





Note: Mention of Brands or Companies does not imply endorsement by RVTEC, UNOLS or Oregon State University, provided for information purposes only

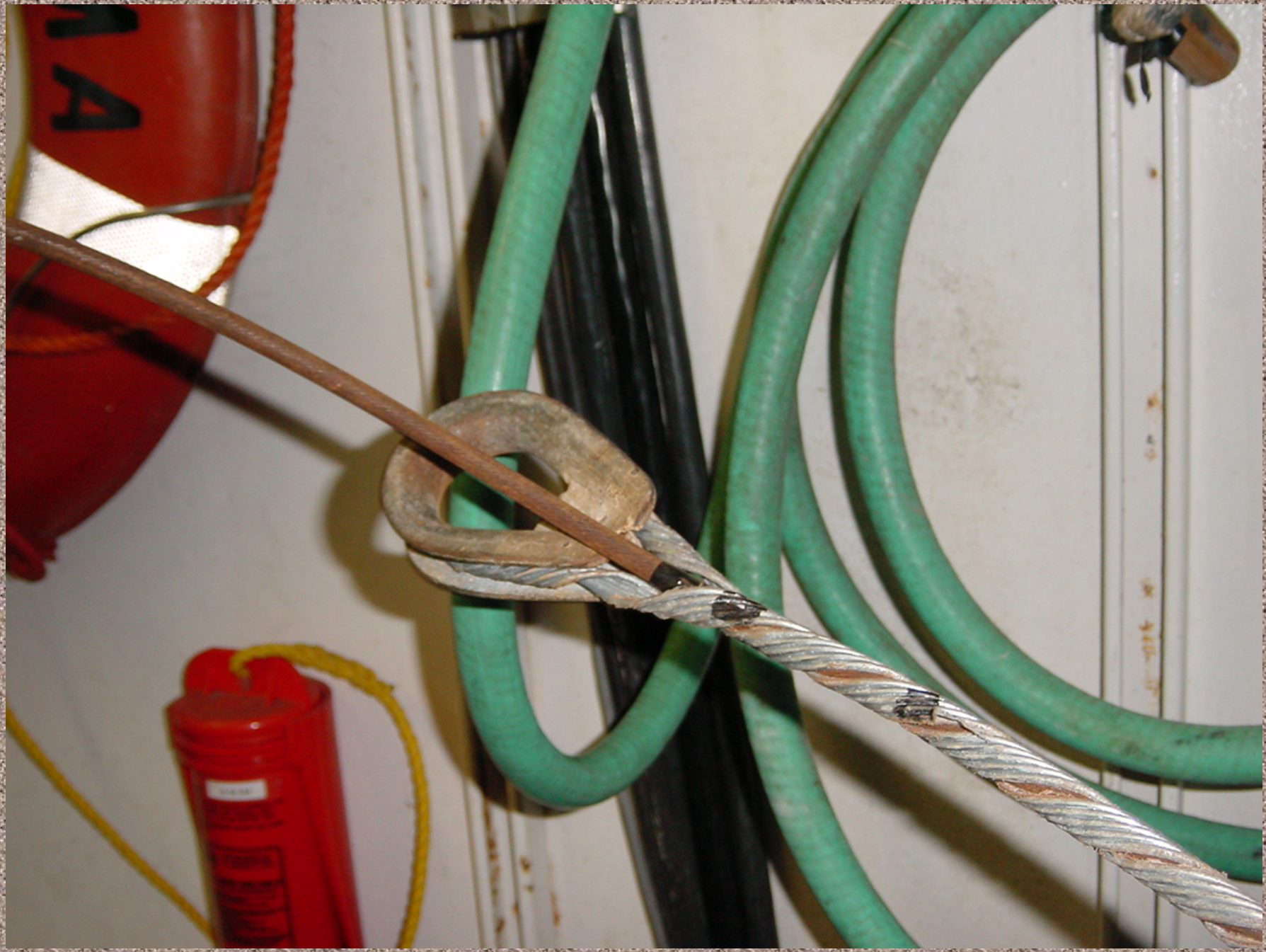


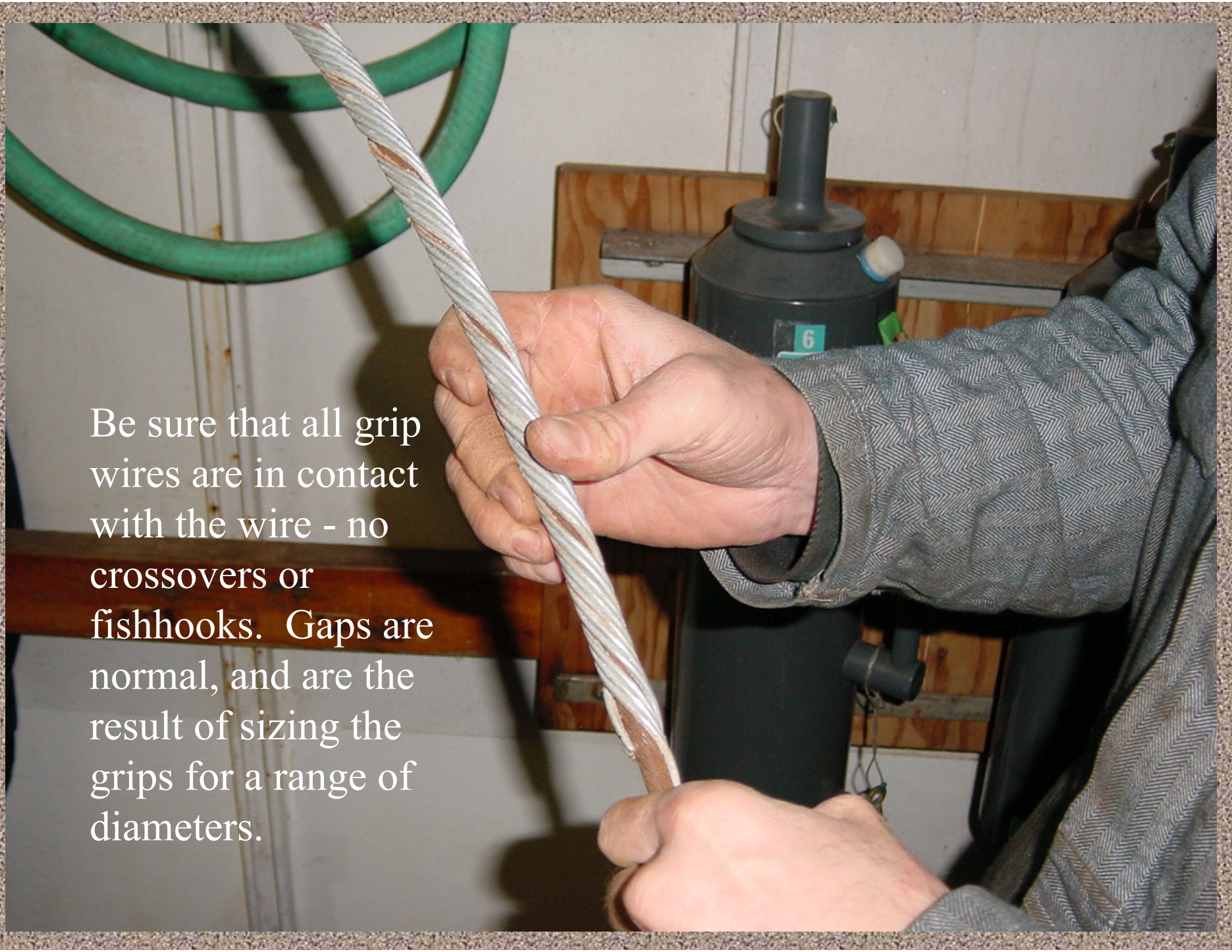
UNOLS .322” wire is Left Hand Lay = LHL

The grip works by friction between grip wires and armor wires. Grip wires are laid the SAME direction as the outer armor.

Using the wrong (opposite) lay grip will result in failure at a much lower tension - the grip will slip instead.

Thimble prevents deformation of the grip eye - extends the life of the termination




Be sure that all grip wires are in contact with the wire - no crossovers or fishhooks. Gaps are normal, and are the result of sizing the grips for a range of diameters.

At this point, the grip termination (with or without thimble) has about 90% of the strength of the cable.

The primary failure mode in this state is ‘unzipping’ from the eye end. We have observed that under high tension, the wire will flip out of the grip turn-by-turn, starting at the eye.

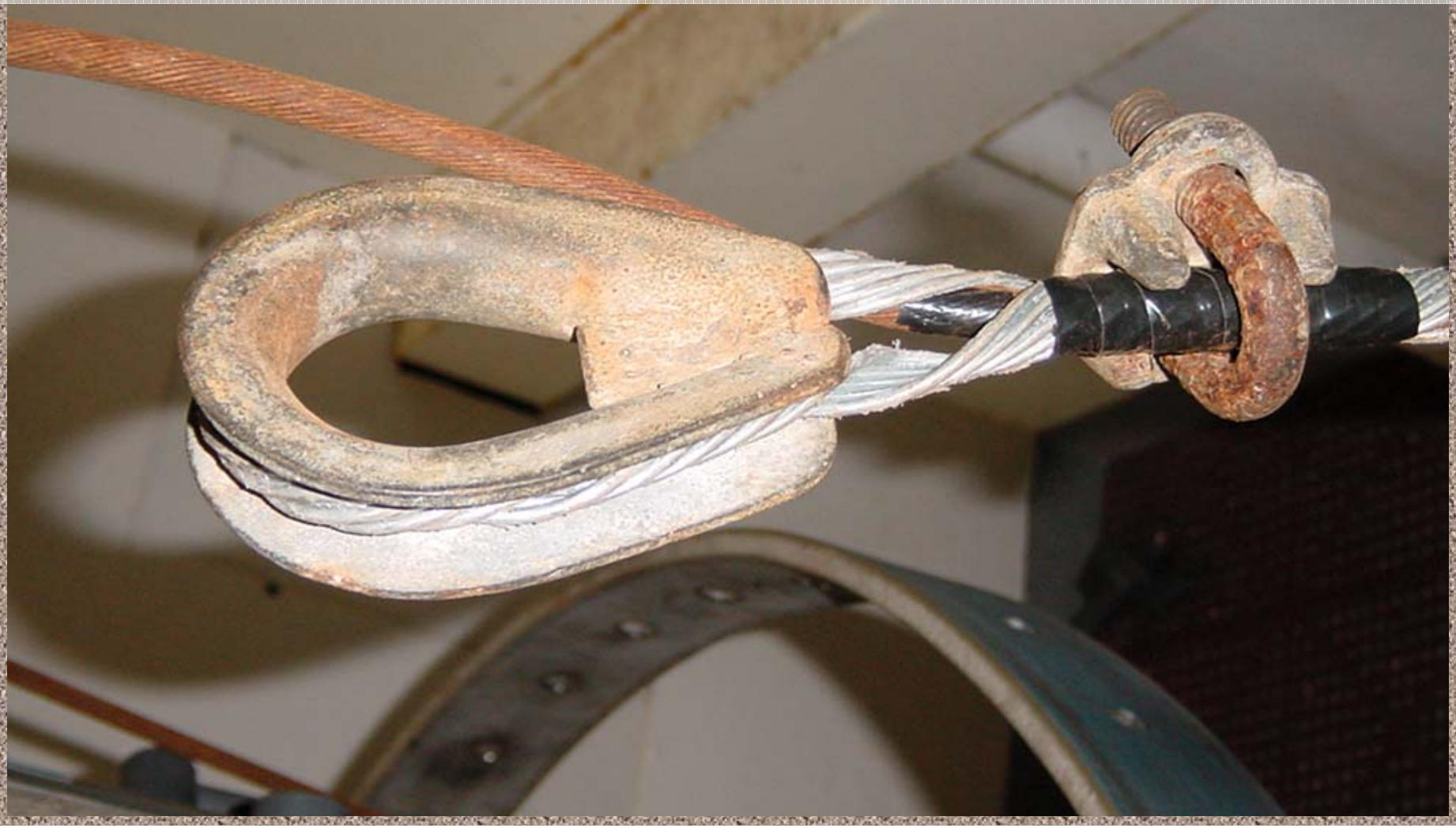
To increase termination strength, a 1/2” Crosby cable clamp can be used to secure the eye end of the grip. To prepare for this, wrap several layers of electrical tape at the base of the eye. This provides a base for the cable clamp to grab.

The Crosby clamp is placed over the tape, and tightened enough to stay in place, and prevent unzipping.

It can be pretty tight, since the cable core is well protected by the armor and the grip wires.

The tape keeps the clamp in place. If tape is not used, the clamp has a tendency to slip - metal on metal contact.

{You'll know there's too much tape when you can't get the U-bolt on.}

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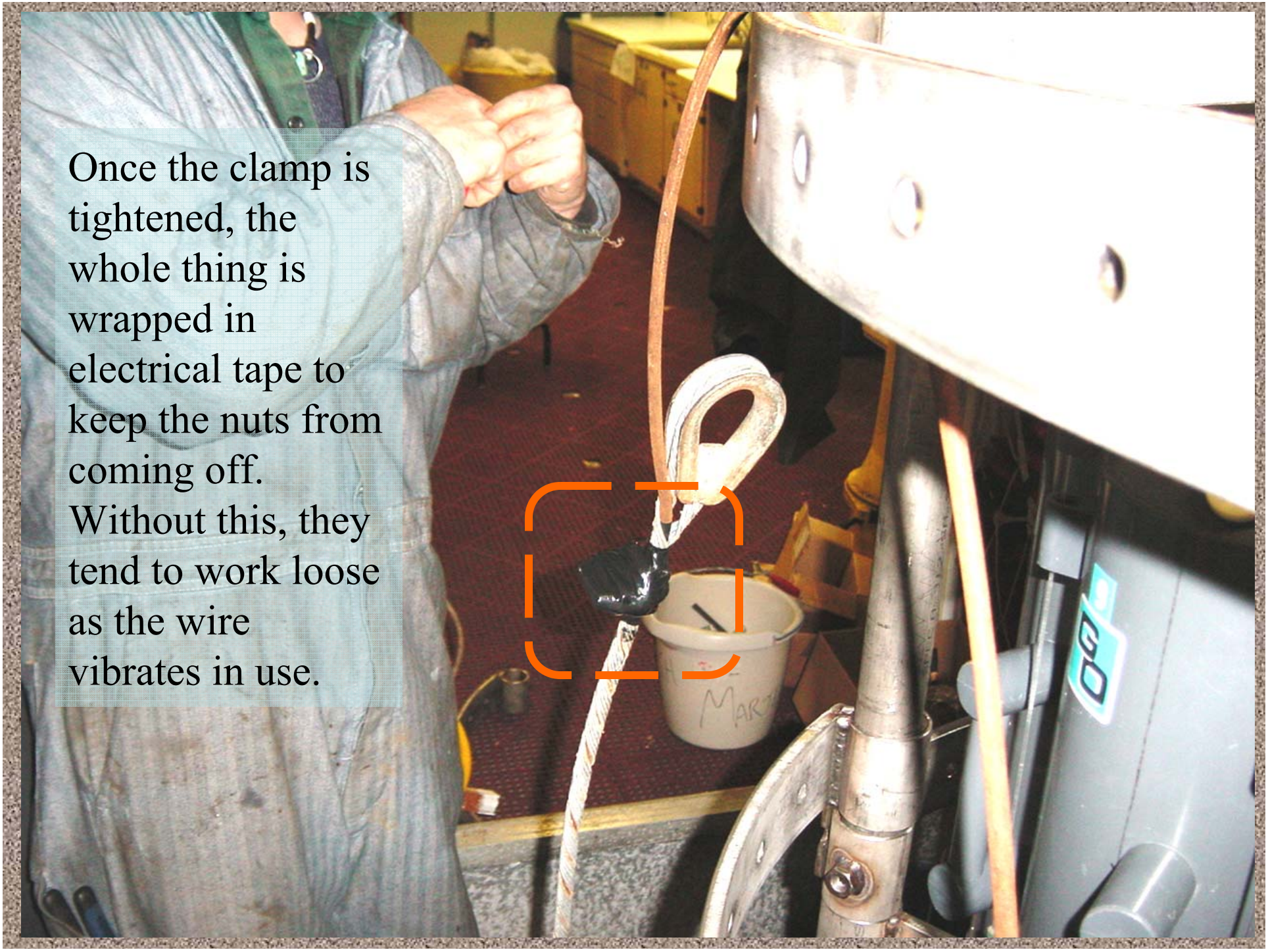
Once the clamp is tightened, the whole thing is wrapped in electrical tape to keep the nuts from coming off. Without this, they tend to work loose as the wire vibrates in use.

Finished termination attached to CTD

It's a good idea to add some tape at the upper end of the grip to keep the wires from working loose, and to prevent hand injuries. Bright tape is a good two-block indicator for winch operators.