Wire Terminations

Improperly installed wire terminations on lighted aids to navigation can fail prematurely causing a difficult to troubleshoot discrepancy. The use of self contained lanterns will solve many of these problems, but many aids, including lighthouses, ranges and medium intensity signals will still use legacy components requiring quality terminations at the battery and equipment.

Stranded copper wire is the preferred conductor on lighted aids due to its low electrical resistance, flexibility and wide assortment of sizes. Bare copper wire in marine environment will oxidize (that greenish coating on the wire strands) which acts as an insulator on compression-type lugs. This oxide will wick up the conductor and make it difficult to make a new crimp termination after the old lug is cut off. When this oxide forms inside a spade or ring lug, the electrical resistance increases, limiting the current through that connection to the point that voltage drop is severe enough to cause the component to fail to operate. Tinned copper conductors offer superior protection to environmental corrosion; tin will still oxidize, but at a lower rate and the tin oxide does not act as an insulator so voltage drop through the lug is not an issue. So, for wires that are terminated in the field, only tinned copper conductors (wire strands appear silver instead of copper) should be used. Bare copper can be used if the wires are tinned (with a soldering iron), soldered to the lugs or a closed end lug is sealed with heat shrink tubing after being crimped. For units using a district-supplied lantern stand where the wire length is known, the best scenario is to make up some 12/2 SO cables of the appropriate length with soldered lugs at each ends. If this cannot be done in-house, COMDT (CG-432A) can provide a suggested source of supply. Additionally, lugs can be soldered on the solar panel leads, but care must be taken to ensure that the stuffing tube can be slid over the lugs; otherwise the stuffing tube can be assembled on the cable before the lugs are attached. Wires that are terminated at devices with a clamp-pad or clamp-screw terminal (Range Power Box, Range Switch Box, etc,) should use tinned copper conductors.

Lugs are available in tinned copper which avoids the corrosion issue at the crimp and under the screw terminal and battery lug. Lugs can be purchased insulated or non-insulated. Insulated lugs are generally used if they are crimped in the field. Non-insulated lugs are used if heat shrink tubing is applied over the termination after the lug is crimped and/or soldered. When soldering, slide a piece of heat shrink up the insulated conductor, apply a liquid or paste rosin flux to the wire, insert into the lug, apply heat to the barrel of the lug and insert solder into the end of the barrel until it is drawn into the strands. Do not use too much solder as it will wick up the wire past the lug and cause the wire to lose flexibility. Slide the heat shrink over the barrel after it cools and use a heat gun to shrink the tubing in place, sealing the insulation and lug to prevent moisture from wicking up the conductor.

Insulated Spring Spade

Non-insulated Ring

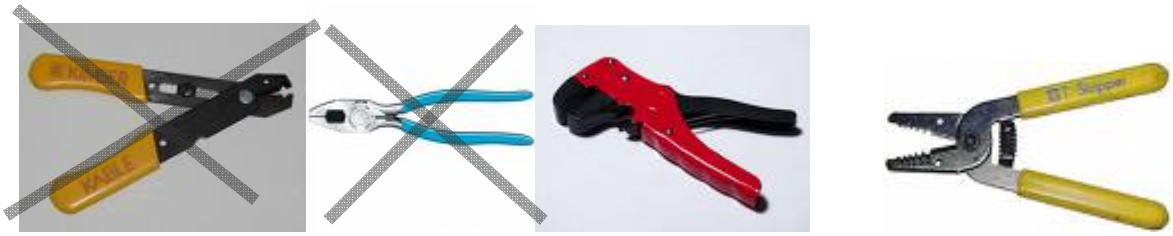
Closed End

Four things must be considered when ordering lugs: wire size, insulated or non-insulated, type of lug and size of lug. With the exception of oversize lugs (for 8 AWG wire are larger), lugs are divided into three general sizes; 10-12 AWG, 14-16 AWG and 18-22 AWG. If insulated, they are color coded as yellow, blue and red, respectively. The proper size lug must be used; too large and the crimp will not contact all the strands and may be loose; too small and some strands will be broken or rejected when the wire is inserted. For components like flasher and lampchangers, I like to use the spring-spade or locking-fork lugs. The locking-fork looks like a spade or fork lug, but will clip in around the screw allowing you to tighten it without holding it in place, yet allows easy removal. All of our flashers use number 8 screw terminals, so lugs should be sized accordingly. Minor aid batteries have either 3/8” studs (Delco) or ¼” bolts (Sunlyte). Ring lugs work best on these applications. Suggested sources are McMaster-Carr and Mouser Electronics.

Barrel Crimper

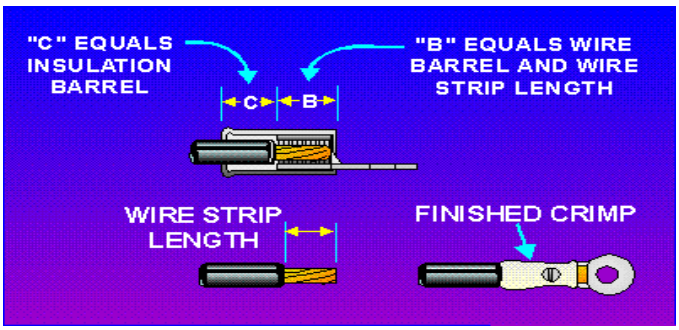
AMP ProCrimper III

The proper crimper must be used when making field connections. An inexpensive "barrel" type crimper will not provide a suitable termination in the marine environment. The suggested crimper is the AMP ProCrimper III which accommodates all three insulated terminals discussed above. Different dies can be purchased if non-insulated lug terminations with heat-shrink tubing are made. Due to the difficulty of changing dies, more than one crimper should be purchased and labeled for the intended purpose (insulated lugs, non-insulated lugs, 10-22 AWG, etc.).



Wire Strippers

Insulation must be stripped with the proper tools. Linesman pliers, dykes and non-adjustable wire strippers can damage insulation, cut or nick wire strands which may prevent a complete crimp because the lug is sized for a specific range of wire diameters. Self-adjusting or stepped wire strippers (above) protect the conductors and provide a clean, square cut of the insulation. The amount of insulation removed from the wire should equal the barrel length "B" shown below. Removing too much insulation exposes the wire strands to the environment and removing too little may not allow an adequate crimp. If wire is oxidized, it should be cut back until clean wire is exposed (if possible) or the wire strands should be cleaned with a wire brush or sandpaper until the conductor shines.



Proper Wire Strip Length

Select the proper crimping tool & die for the wire size and type of lug (insulated or non-insulated). Slide a piece of heat shrink tubing up the wire if using non-insulated lugs and make the crimp. Proper crimps for both types of lugs are shown on the next page.

Proper Crimp – Insulated Lug

Proper Crimp – Non-Insulated Lug

Lugs for 6 AWG and larger conductors should not be soldered as it is difficult to apply enough heat for a good connection due to the mass of the lug and conductor. Use closed end lugs to seal the end of the conductor and apply heat shrink tubing to seal the insulation to the barrel. The compression lugs are easy to use in the field, but must be sized for the specific conductor and lug. Large closed end lugs require a specific crimping tool to ensure an adequate connection. Consult with the manufacturer's recommendations when purchasing lugs.

Closed End Lugs

Compression Lug

Crimped & Heat Shrink

Lugs for large Conductors