

Western Underground Committee

Guide 2.5

Bare & Submersible Low Voltage Connector Systems

NOTE: This “Guide” summarizes the consensus of opinions, recommendations and practices of the Western Underground Committee members as constituted at the time of issue. It is intended to assist these members in preparing their own specifications, or in making recommendations to specification agencies. Therefore, this “Guide” may not reflect the complete requirements of each member utility and is not binding upon them.

1. SCOPE

- 1.1 **General.** This guide covers systems used for connecting low voltage (600V) cables, which may also include insulating and environmental sealing.
- 1.2 **Tests and Requirements.** Included are material tests and performance requirements for the connectors, and insulation and environmental sealing when required.
- 1.3 **Compliance.** Unless otherwise stated, compliance with, and verification of, all applicable tests provided herein shall be the responsibility of the connector manufacturer. If insulating materials are provided to the connector manufacturer by another manufacturer, that manufacturer’s test results may be used.
- 1.4 **Application.** The user should verify application with the manufacturer when proposed use is different than intended.

2. REFERENCED STANDARDS & GUIDELINES

All standards & guidelines referenced shall be the latest edition.

ANSI C119.1	Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI C119.4	Connectors for Use Between Aluminum-to-Aluminum or Aluminum-to-Copper Bare Overhead Conductors
ANSI/ICEA S-81-570	Standard for 600 Volt Rated Cables of Ruggedized Design for Direct Burial Installations as Single Conductors or Assemblies of Single Conductors
WUC 2.4	Heat-Shrinkable Splice Tubing

3. REQUIREMENTS

- 3.1 **Installation.** No special tools, and only basic line working skills shall be required.
- 3.2 **Intended Use.** The connector system shall be suitable for above or below ground installation, in air, or enclosure, or directly buried in earth. A submersible connector shall be capable of being submerged under water continuously.

- 3.3 **Conductor Range.** The connector system design shall accommodate a range of conductor sizes from #14 AWG to 1000 kcmil, with a 5% ovality, in aluminum or copper or combinations of aluminum and copper.
- 3.4 **Re-entry.** Multi-tap devices shall allow future additions of cables without disturbing existing cables or degradation of other requirements.
- 3.5 **Temperature Operating Range.** The connector system shall be capable of installation and operation within a temperature range of -30°C to 140°C.

4. APPROVAL DATA

The following data shall be provided.

- 4.1 **Certified Test Reports.** Copies of the test data from all required tests in Sections 7, 8 and 9 of this guideline.
- 4.2 **Drawings.** Pertinent drawings of the connector system, including all dimensions, tolerances, and assembly instructions.
- 4.3 **Material Specifications.** The alloy type, conductivity and minimum yield strength of the metallic part or parts of the connector. Type of plating and lubrication on set screws. Type of inhibitor, when used. Note: This includes appropriate MSDS documentation.
- 4.4 **Torque.** Maximum and minimum recommended torque.
- 4.5 **Tool and Die Information.** Required tool, die and number of compressions, for major tool manufacturers.
- 4.6 **Ampacity.** The connector shall have its continuous ampacity rating determined as follows:
 - 4.6.1 A bar type connector, where the source current is supplied by a round copper transformer bushing stud, shall have the same continuous rating as the size of the stud to which the connector is attached.
Eg. 5/8" – 680A. 1" – 1200A.
 - 4.6.2 A bar type connector, where the source current may be supplied by two or more cables, shall have a continuous current rating equal to the largest size cable applicable, times one half the number of positions in the connector. The source cables shall be grouped together separately from the load cables.
 - 4.6.3 An "end-to-end" or 2 port bar type connector, where the source current is supplied by one cable, shall have a continuous current rating equal to the largest size cable applicable.

5. PACKAGE MARKING

Each connector package shall be clearly marked with the following information.

- 5.1 **Manufacturer Information.** The manufacturer's name and part (catalog) number, date of manufacture.
- 5.2 **Conductor Compatibility.** Statement of suitability for use with; aluminum only, copper only, or combination of aluminum and copper.

- 5.3 **Conductor Range.** Range of conductor sizes for each position on the connector and maximum number of positions.
- 5.4 **Class A Connector.** ANSI C119.4 “Class A” connector rating.
- 5.5 **Torque.** The maximum and minimum recommended torque.
- 5.6 **Tool and Die information.** Required tool, die and number of compressions, for major tool manufacturers.

6. CONNECTOR MARKING

The following information shall be marked on the exterior of the connector body.

- 6.1 **Manufacturer Information.** The manufacturer’s name and part (catalog) number, date of manufacture.
- 6.2 **Conductor Compatibility.** Statement of suitability for use with; aluminum only, copper only, or combination of aluminum and copper.
- 6.3 **Conductor Range.** Range of conductor sizes for each position.
- 6.4 **Tool and Die information.** Required tool, die and number of compressions, for major tool manufacturers.
- 6.5 **Cable Insulation Strip-Back Length.**
- 6.6 **Cable seal cut-off.** The cable seal shall have the cut-off locations identified for the various size cables.

7. CONNECTOR DESIGN TESTS

The following tests shall be performed by the manufacturer on at least four (4) samples of the same size & type for each cable metal applicable. 100% success rate is required to demonstrate compliance with this specification.

- 7.1 **Heat Cycle.**
 - 7.1.1 Bare connectors shall pass the class “A” heat cycle tests specified in ANSI C119.4.
 - 7.1.2 Insulated connectors shall pass the class “A” heat cycle tests specified in ANSI C119.1.
- 7.2 **Mechanical.** Connector system shall pass the Class 3 mechanical tests specified in ANSI C119.4.
- 7.3 **Torque Requirements.** The connector system shall pass the torque withstand requirements specified in ANSI C119.4. In addition to cracking, thread and fastener to tool interface distortion shall be considered unacceptable damage.

8. INSULATION AND SEAL DESIGN TESTS FOR SUBMERSIBLE CONNECTORS

The following tests shall be performed by the manufacturer on at least four (4) samples of the same size & type for each cable metal applicable. Each connector shall have a minimum of 2 cables installed (1 largest, 1 smallest). 100% success rate is required to demonstrate compliance with this specification.

- 8.1 **Impact & Thermal Loading Crack Resistance.** At room temperature, a 40 In.Lbs. impact using a blunt impact tool as specified in ANSI S-81-570 sect. 6.2.3. shall be applied to the samples at the following locations. A) Middle of long end. B) Middle of short end. C) A corner D) Side of tool entry port. E) Side of cable seal. The samples shall be oven aged at 100°C +/- 1°C for 96 hours. No cracks shall appear following removal from the oven or 1 hour after removal.
- 8.2 **System Integrity.** The insulated connector system shall pass the integrity of seal and connector insulation tests specified in ANSI C119.1, Section 4.3. However, the flex and twist and water immersion portion shall be conducted as described in 8.3.
- 8.3 **Moisture Resistance.** Any interface between the cable and connector insulation, between sections of boot, sleeve, container, or plugs or removable cable covers shall prevent leakage while submersed in water.
- 8.3.1 The radius (R) shall be based on the larger cable.
- 8.3.2 The insulated connector system shall be clamped and subjected to the flex (vertical bend) (Figure 1) and horizontal twist (Figure 2).
- 8.3.3 The assembled connector shall be subjected to 10 flex cycles, followed by 5 twist cycles. One additional flex followed by one horizontal twist shall leave the assembly with a 90° bend and a 45° twist.
- 8.3.4 The assembled connectors shall be immersed in 25°C +/-5°C water saturated with sodium chloride with a head of three feet for at least 24 hours while the connector is energized at 600V AC in the bent & twisted configuration.

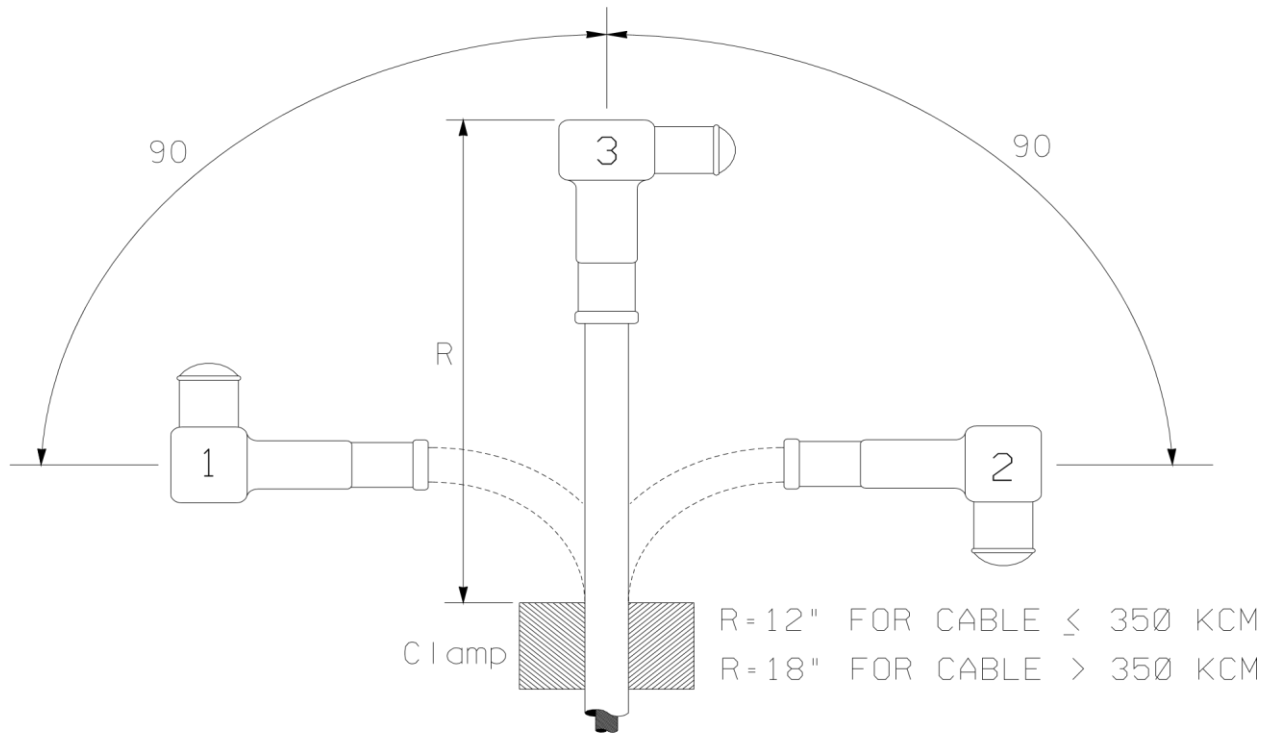


FIGURE 1 - VERTICAL BEND

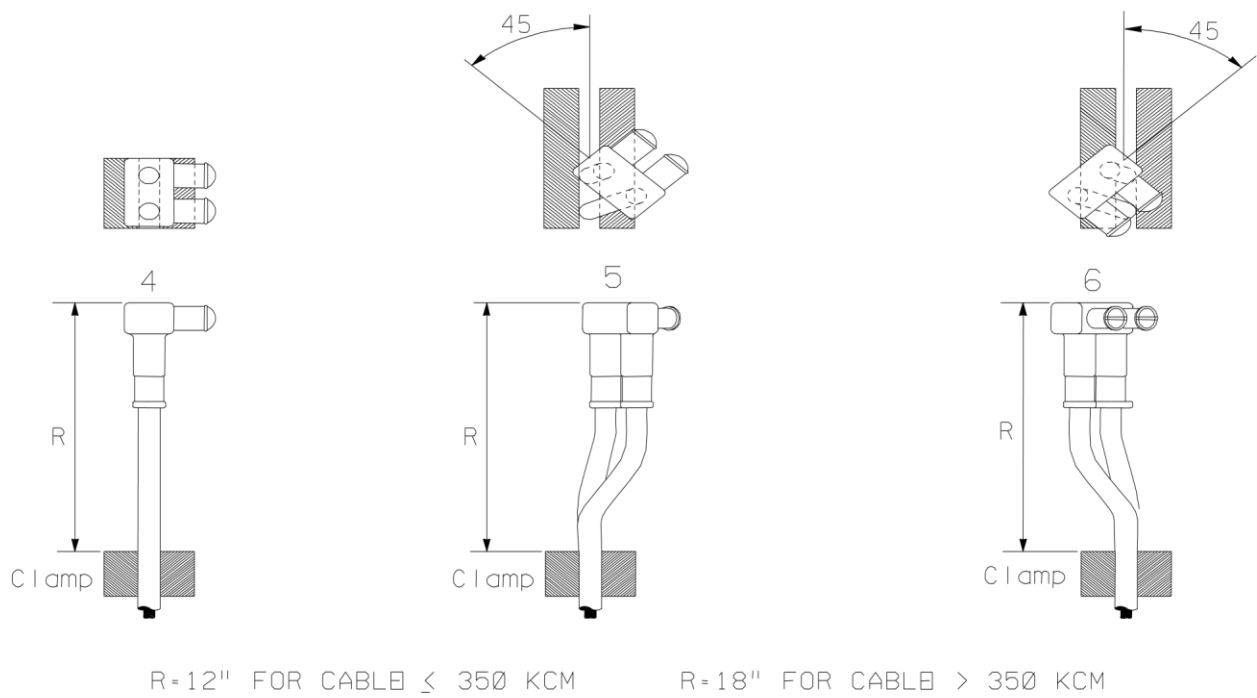


FIGURE 2 - HORIZONTAL TWIST