



TO: To Whom It May Concern
FROM: Codes & Standards
DATE: 03/22/2021
RE: Specifications for Ruggedized USE-2 Conductors

Technical Document

This Technical Document will introduce a standard related to conductors rated for Ruggedized Installation based on the Insulated Cable Engineer Association (ICEA) standard. We will review the ICEA standard S-81-570 “Standard for 600 Volt Rated Cables of Ruggedized Design for Direct Burial Installations as a Single Conductors or Assemblies of Single Conductors”. Conductors related to this standard are suitable for direct burial, duct, conduit, subsurface cable trench and installation in locations exposed to weather and sunlight.

This “Ruggedized Cable” standard is mainly used by some electric utilities who have moved this type of cable for below ground installations in areas with rocky soil. This product has shown to be more mechanically resistant in trenches and allow less insulation penetration from rocky soils.

For Encore Wire, the product we promote for Ruggedized applications is our USE-2, 600-volt aluminum or copper conductor insulated with a cross-linked thermosetting type polyethylene. The cable will be furnished in Single, Duplex, Triplex, or Quadraplex, assembly for use as secondary cable in the Underground Residential Distribution (URD) system or also known as Underground Distribution Cable (UDC) when not being utilized in Residential settings. Listed in Table 1 are the conductor sizes, insulation thickness, and test voltages.

Table 1. Conductor Sizes, Insulation Thickness, and Test Voltages

Conductor Size (AWG or kcmil)	Insulation Thickness Mils (mm)	Test Voltage Spark (AC), kV	Test Voltage Spark (DC), kV
8 – 2	60 (1.5)	16.0	22.5
1 – 4/0	80 (2.0)	18.5	29.5
250 – 500	95 (2.4)	22.5	35.0
501 – 1000	110 (2.8)	28.5	40.0

To qualify for Ruggedized Design, the conductor must go through a series of Mechanical Abuse Tests which are found in the ICEA Standard S-81-570. The Mechanical Abuse Resistance Requirements consists of the Sharp Impact, Blunt Impact, Abrasion, Crush, Puncture, and Scoring Test. Conductors meeting all the minimum values of Table 2 will



provide abuse resistance. It is possible for some insulations material to meet one or more of the abuse resistant tests, but not all. Conductors that do not meet all the minimum requirements in Table 2 are not considered abuse resistant or ruggedized.

Mechanical Abuse Resistance of Insulation

The Mechanical Abuse Test shall be performed on a sample length 1/0 AWG Class B stranded aluminum or copper conductor 80-mil nominal insulation thickness cable.

- 1. Sharp Impact.** This test comprises of 5 determinations of sharp impact resistance. An electronic latch or flash circuit or the equivalent shall be provided to detect the first contact between the tool and the conductor in the specimen.* A vertical force shall be applied to the conductor and the impact resistance (The product of the vertical distance and 4.25 pounds) shall be recorded.
- 2. Blunt Impact.** The impacting instrument for the Blunt Impact is a similar design, but a sharper point than the instrument used in the Sharp Impact Test. This test comprises of 5 determinations of sharp impact resistance. An electronic latch or flash circuit or the equivalent shall be provided to detect the first contact between the tool and the conductor in the specimen.* A vertical force shall be applied to the conductor and the impact resistance (The product of the vertical distance and 4.25 pounds) shall be recorded.
- 3. Abrasion.** A 15-inch sample shall be placed at 90-degree, in a V-shaped slot of the mounting base and ends secured to prevent moving. The mounting base shall be secured to a flat, horizontal table that moves in a horizontal plane in a direction parallel to the longitudinal axes of the specimens. With the table at one end of its travel, the table shall be started in horizontal reciprocating motion at the rate of 30 to 36 cycles per minute parallel to the longitudinal axis of the specimen with each cycle consisting of one complete back-and-forth motion with a six-inch stroke. A counter is provided to record the number of cycles. An electrical circuit shall be provided to record the first contact between the tool and the conductor specimen, and to halt the motion of the table at the number of cycles at which the first contact occurs.* Six specimens shall be tested until contact occurs.
- 4. Crush.** This test shall be in a compression-testing machine. 10-Specimens shall be tested. Each specimen shall be laid flat on the table. Each specimen shall be tested separately and subjected to an increasing force until the first contact takes place between the conductor in the specimen and the round stock or the upper plate. An electric latch or flash circuit or the equivalent shall be provided to detect the first contact.* The force in pounds (N) necessary to produce the first contact shall be recorded as the contact point.
- 5. Puncture.** This test shall be in a compression-testing machine. A puncture shall be made with the puncture tool. 10-Specimens shall be tested. Each specimen shall be laid flat on the table. Each specimen shall be tested separately and subjected to an increasing force until the first contact takes place between the



conductor in the specimen and the round stock or the upper plate. With the plate and the tool connected, the tool shall be lowered at a rate of .5 inch per minute and increasing the puncture force until contact takes place between the conductor in the specimen and the tool. An electric latch or flash circuit or the equivalent shall be provided to detect the first contact.* The force in pounds (N) necessary to produce the first contact shall be recorded as the contact point.

- 6. Scoring.** This test shall include a scoring tool to test six specimens 15-inch sample, placed at 90-degree, in a V-shaped slot of the mounting base and ends secured to prevent moving. The mounting base shall be secured to a flat, horizontal table that moves in a horizontal plane in a direction parallel to the longitudinal axes of the specimens. The base may contain as many as six slots to allow simultaneous testing. A weight shaped as necessary shall be placed in the hole at the top of the tool such that the total force brought to bear on the specimen by the tool and the weight shall be 2.0 pounds. With the table at one end of its travel, the table shall be started in horizontal reciprocating motion at the rate of 30 to 36 cycles per minute parallel to the longitudinal axis of the specimen with each cycle consisting of one complete back-and-forth motion with a six-inch stroke. A counter is provided to record the number of cycles. An electrical circuit shall be provided to record the first contact between the tool and the conductor specimen, and to halt the motion of the table at the number of cycles at which the first contact occurs.* Four measurements of the number of cycles-to-scoring-contact shall be made on each of at least six specimens. After the first measurement, each specimen shall be turned 90-degrees around its own axis and a second measurement made. Likewise, with a similar 90-degree turn, a third and fourth measurement shall be made.

***Each of the Abusive Resistance Test tools will automatically stop when the test tool makes contact with the conductor material (copper or aluminum). This is an indication that the tool has penetrated the insulation and has made contact with the conductive material. Table 2 reflects the minimum values that a failure should be detected.**

Table 2. Abusive Resistance Properties

TEST	UNITS	MINIMUM AVG. VALUES
Sharp Impact	Pound-force-inch (N*m)	10 (1.1)
Blunt Impact	Pound-force-inch (N*m)	40 (4.5)
Abrasion	Cycles to fail	200
Crush	Pound (N)	650 (2890)
Puncture	Pound (N)	50 (220)
Scoring	Cycles to fail	200



In summary, Encore Wire's USE-2 have been fully tested and approved for voluntary compliance with ICEA standard S-81-570, the "Standard for 600 Volt Rated Cables of Ruggedized Design for Direct Burial Installations as a Single Conductor(s) or Assemblies of Single Conductors" assuring the electrical industry of acceptable results based on the Sharp Impact, Blunt Impact, Abrasion, Crush, Puncture, and Scoring testing procedures.