



TYPE W PORTABLE POWER CABLES

Effects of Cold Ambient Temperatures on Rubber Type W versus Plastic Type PPE

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INTRODUCTION

The need for portable power continues to increase throughout North America. Extreme weather conditions, storm outages, rural and remote locations, as well as non-permanent project-related installations are all needs where Carol® Brand Type W portable power cables have been used for decades. General Cable's Super Vu-Tron® Single Conductor Type W Extra-Flex cable is the industry leader in performance and value for the temporary power user because of its versatility and performance in all sorts of extreme environmental conditions.

Carol Brand portable cables power the demands of entertainment and stage lighting applications within the television, sports and motion picture industries. The applications where these Type SC and Type W cables are used range for stage lighting use. All of these applications rely on the high-quality construction and physical properties of these cables to ensure long life and reliable service under demanding environmental and soundstage conditions.

Many temporary power installations are time-constrained, and when temporary power is necessary, it is usually needed in a hurry. Temporary power cables must be easy to install and use, no matter what the weather or environmental condition. Installers almost always feel the pressure to get the power up and running, particularly when restoring it to neighborhoods, businesses, and critical services after a major storm.

Over the past year, General Cable's Wire Wizardssm have heard often from customers after major events where portable power was needed fast, indicating our Super Vu-Tron Single Conductor Type W Extra-Flex cable outperformed other cables, particularly plastic-constructed cables (Type PPE constructions). Our customers found our Super Vu-Tron rubber construction in particular maintains flexibility even at cold temperatures, where plastic cables tend to stiffen and become less pliable.

Even more noteworthy, we heard from our customers about the problem of "cold memory" in alternative cables – the tendency of a cable to retain the coiled reel shape even after rolling it out in the field during installation. Cold memory is a problem for the installer because it requires extra work to lay the cable out and connectorize it. Cables with cold memory also do not make for an orderly installation, as they do not lay flat on the ground. In addition, the "coiling" effect makes it difficult to create neat, orderly and safe wireways from the generation source to a load center.

Based on this customer feedback, the Carol Wire Wizards more closely examined the differences between rubber (Super Vu-Tron Type W) and plastic (Type PPE) constructions in cold weather conditions. Comparative testing of Carol Type W products and those made by a leading plastic manufacturer was performed to answer the following key questions:

- How is "cold memory" displayed during cold weather conditions, and what impact does it have on the installer?
- What are the physical flexibility and ease-of-use characteristics of Type W rubber cable versus Type PPE plastic constructions at low temperatures?



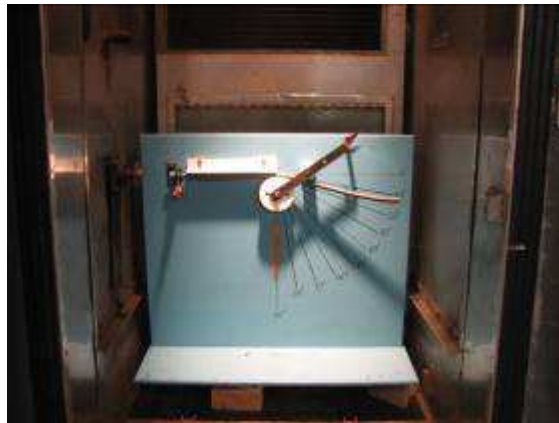
TEST RESULTS

Two separate tests were used to determine the ease-of-use for Super Vu-Tron Type W Single Conductor Extra-Flex cable versus a competitor's plastic (Type PPE) constructed cable, specifically to see how each perform in cold temperatures:

- Low Temperature Deflection Test, which determines the amount of torque required to bend a cable through a 90° bend.
- Cold Memory and In-Service Test, which determines the in-service length shortening and user-friendliness of a cable in service.

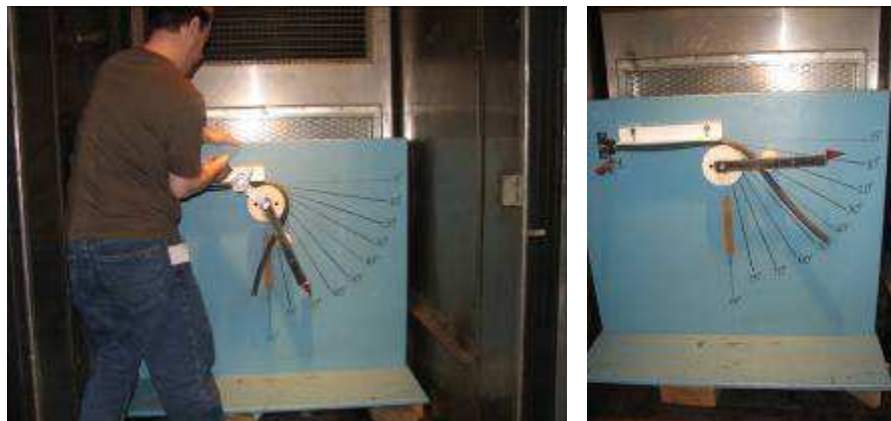
Low Temperature Deflection Test

For low temperature deflection analysis, General Cable engineers utilized a deflection test method that measured the amount of deflection torque (effort) required to bend a cable through a 90° bend. A sample of 4/0 AWG Type PPE plastic cable and sample of Carol Brand Super Vu-Tron 4/0 Type W rubber cable were placed in an environmental chamber, and allowed to cold soak at -30°C for a period of four (4) hours (see **Picture 1**).



Picture 1

Each sample was then placed in the bending test apparatus. The bending forces measured the bend of the cable around a 5-inch cylinder until the cable achieved a 90° bend (see **Picture 2**).



Picture 2



The amount of force applied over the 5-inch distance was used to calculate the deflection torque, or effort required to bend. Lower values of deflection torque demonstrate that the cable is easier to work with in a cold weather installation.

The test results are shown below for -30°C ambient temperatures:

Cable Type and Construction	Deflection Torque (inches per lb)
Carol Super Vu-Tron Type W Rubber – 4/0	220 in/lb
Brand X – Type PPE (TPE Plastic) – 4/0	280 in/lb (27.2% greater effort required)

The larger deflection torque required to bend the cable means that in cold weather conditions, Type PPE (TPE plastic) cable is more difficult to lay, install and connect, and overall, will be more difficult to manage than Carol Super Vu-Tron Type W Rubber cable. The 27% difference in effort required is significant, as it could mean the difference of requiring an additional installer on a 4-man crew, or the equivalent amount of extra time required to complete the job. Carol Brand Super Vu-Tron Type W is the better choice because of its ease of use at cold temperatures.

Cold Memory and In-Service Test

For the cold memory analysis, General Cable engineers utilized equal lengths of each cable type coiled on a wooden spool. Per typical UL requirements, each test was conducted at four-hour increments at several desired temperatures. The cable test samples were prepared in the following manner:

- Equal 26-foot lengths were cut of Type PPE (TPE plastic) cable and Carol Brand Super Vu-Tron Type W rubber cable, both with an overall diameter of 1-inch.
- Each length was coiled on one wooden spool with an outer diameter of 56.75” to ensure the cables did not overlap or interact with one another. The ends of each cable were then secured with electrical tape (see **Picture 3**).



Picture 3

Each wooden spool was then placed in an environmental chamber, where the engineers set a variance for both time and temperature at +10°C for 4 hours to -10°C for 16 hours (see tables on the following page).



Cold Memory and In-Service Test Results

10°C for 4 Hours			
Product	Initial Length	Final Length	% Recoil
GCC	26'1"	25'11"	99.36%
Competitor	26'1"	25'1"	96.17%

0°C for 4 Hours			
Product	Initial Length	Final Length	% Recoil
GCC	26'1"	24'6"	93.93%
Competitor	26'1"	22'1"	84.66%

-10°C for 4 Hours			
Product	Initial Length	Final Length	% Recoil
GCC	26'1"	22'7"	86.58%
Competitor	26'1"	21'0"	80.51%

-20°C for 4 Hours			
Product	Initial Length	Final Length	% Recoil
GCC	26'1"	23'3"	89.14%
Competitor	26'1"	17'2"	65.81%

0°C for 16 Hours			
Product	Initial Length	Final Length	% Recoil
GCC	26'1"	23'7"	90.42%
Competitor	26'1"	21'0"	80.51%

-10°C for 16 Hours			
Product	Initial Length	Final Length	% Recoil
GCC	26'1"	22'9"	87.22%
Competitor	26'1"	18'11"	72.52%

Upon removal of the spools from the environmental chamber, the cables were quickly unspooled and stretched out on the ground as they would typically be in an actual field installation. Each 26-foot cable length was then re-measured to determine the resulting cold memory, coiling and cable length shrinkage. As demonstrated by the above tables, the **General Cable Type W Rubber cord sees relatively minor changes in coiling during the -10°C and 0°C trials**. The product still is comparatively easy to work with when taking it off the spool and putting it back on. It is as if you are working with a garden hose.

However, the Competitor Type PPE Plastic product coils on the ends and in the middle even more than in the -10°C trial (see **Picture 4**), making it extremely difficult to work with. In addition,

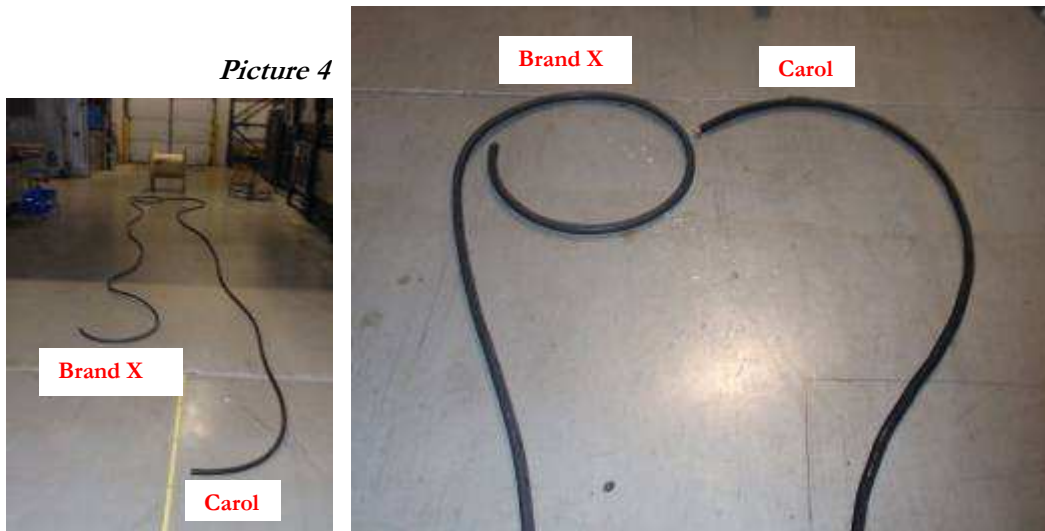


the competitor's product feels semi-rigid possibly due to the insulation in the cable. During the worse case at -20°C for four hours, the competitor's cable is almost **9' shorter** than its original length and more than **6' shorter** than the General Cable product due to the coiling that occurs.

As with the deflection test, the cold memory and in-service test results further confirm the advantages of Carol Brand Super Vu-Tron Type W rubber cable over the competitor's plastic cable construction. As time is money, it is critical that the product is user-friendly for both the installer and for use in any environment.

VISUAL COMPARISON

In creating compelling stories for the entertainment audience, producers rely on striking visuals to convey important themes to the public. The comparative visual of the Type W rubber cable versus the and Type PPE plastic cable tell a similar story – the long-known story of Carol Brand's high-quality, as when compared to lesser-quality cable.



CONCLUSION

For the production engineer and installer seeking the best quality temporary power cable product that will perform under all the demanding conditions required for entertainment and stage applications as well as critical portable power applications, the clear choice is Carol[®] Brand Super Vu-Tron[®] Type W Extra-Flex rubber cables, as well as our Type SC cables. Be assured, the Carol history of quality and innovation remains true today, with our focus on product engineering improvements and unyielding conformance to UL, CSA and MSHA certification standards. Even more, Carol Brand cables are not only easy to use—retaining their shape, durability and integrity after years of use—they are also reliable, setting the standard of performance in extreme heat and cold conditions and under the demanding push/pull conditions well-known in the industry.

Our focus on producing the best quality entertainment, stage lighting and portable power cable in the industry is a direct reflection of our motto with Carol[®] Brand: *Demand Better...Expect More™*.