SOUTHWIRE Technology Center

Performance Analysis of 1/0 25kV PowerGlide™ MV Jacket

Report by: C. L. Holcombe/Philip Sasse July 1, 2008
Reviewed by: Stephen Spruell

Introduction

The Southwire Energy Division and the Cofer Technology Center were given the task of testing the performance of the new PowerGlide™ MV jacket. The PowerGlide™ MV jacket was developed to make it easier to push or pull medium voltage cable into conduit. This new jacket is a modified version of the standard linear low-density polyethylene (LLDPE) non-conductive, medium voltage jacket, where a lubricating component is compounded into the jacket. This lubrication reduces the coefficient of friction between the cable jacket and the conduit. The cable that was tested was a 1/0 Solid Aluminum 25kV medium voltage cable with a "full" copper concentric neutral.

Coefficient of Friction: Testing Procedure

Coefficient of friction (COF) tests were performed at the Cofer Technology Center. In these tests, the PowerGlide™ MV jacket was tested to determine coefficient of friction when pulled into a PVC conduit. Southwire tested for four different COF values. To perform this test, the PowerGlide™ MV jacket was extruded onto a 4/0-19 bare copper conductor. Three cables were pulled thru a 30-foot straight section of 2 inch PVC conduit, and then pulled thru two 2-inch 90-degree elbows with a 12-inch radius. Finally, the conductors were pulled out through a 10-foot section of 2 inch PVC conduit. A back tension was placed on the conductors for each pull that factored into the calculation for coefficient of friction. Once the pulling head exited the elbows, data points were taken continuously to determine a final pulling tension. This pulling tension was then used to reverse calculate a coefficient of friction for the PowerGlide™ MV jacket. The lubrication used during this test was Polywater® Lubricant J and was applied per manufacturer's specifications. Four different series of tests were conducted at the Cofer Center. First, two pulls with a jacket made from standard LLDPE were tested. One sample was lubricated before entering the duct and the other was not lubricated. The second two pulls were made with the PowerGlide™ MV jacket. One of these cables was lubricated before entering into the duct, and the other did not have any external lubricant applied. The conduit was replaced after the conduit was contaminated with lubricant. The results of these tests are detailed later in the report.

Field: Testing Procedure

Testing of "installation-ease" of Southwire's new PowerGlide™ MV underground medium voltage cable was accomplished at an internal jobsite designed to approximate the toughest of real-world installation situations, while using a smaller-scale facility and less wire than might be used on a real-world installation. To accomplish this, a pull program was used to design a pull that would, under normal conditions, produce pull tensions of 1500-2000 pounds, which would approximate the highest tensions that should be encountered on a jobsite.

The pull was designed for an installation of three 1/0 solid aluminum 25 kV conductors in 3" PVC conduit. This approximates the conduit fill ratio (38%), of a common, larger installation of three 1000 kcmil 25 kV conductors in 6" conduit. To increase the difficulty of the pull and the pulling tension, multiple 90° sweeps were included in the pull layout. To simulate entering a manhole to access an underground duct, the pull starts with a 10' horizontal run, a 45° elbow to direct the cable downward, a three-foot vertical drop (at a 45° angle), followed by another 45° elbow to return the run to horizontal. At floor level, a level run of 250' was followed by a turnaround through two 3'-radius 90° sweeps. Another 250' straight was followed by two more 90° sweeps, then a final 10' run allowed the cable to emerge at floor level. Elbows and sweeps were made of metal (EMT) to prevent the pulling rope from burning through the PVC. A layout of the pull is shown below in Figure 1.

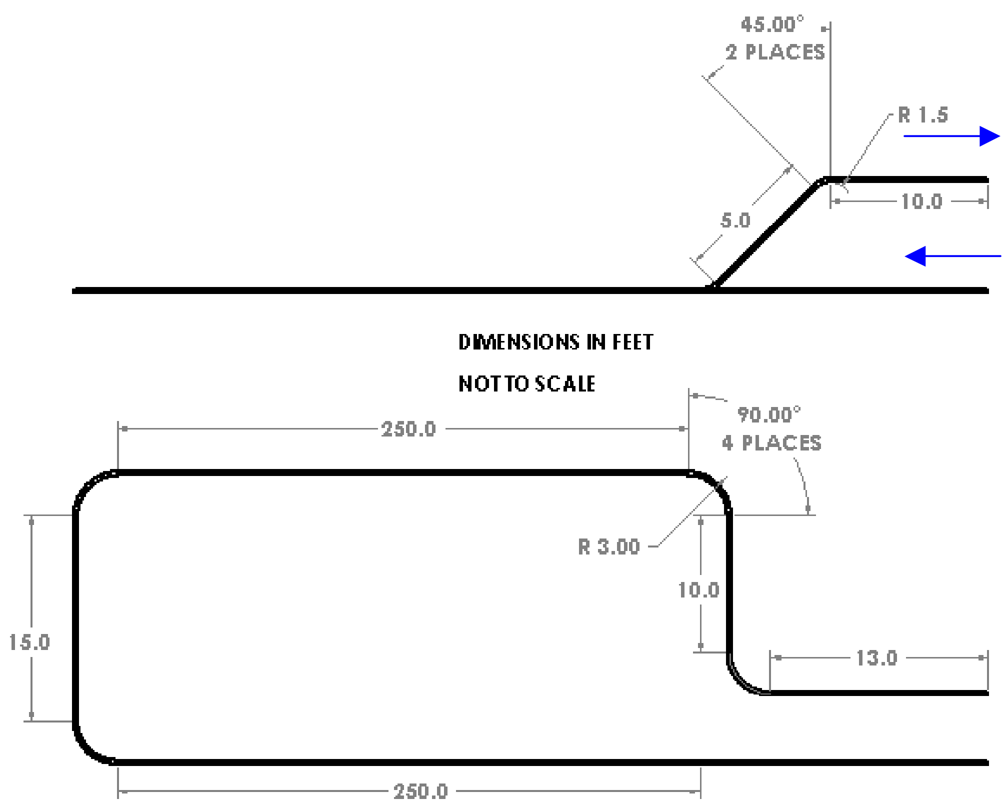

Figure 1: Approximate Layout of Conduit Run

The cables were pulled using a Greenlee Ultra Tugger® 8 (maximum capacity 8000 lbs) fitted with a Greenlee Deluxe Force Gauge, which uses a load cell to directly measure the tension on the pulling rope at the tugger (unlike most tugger force gauges, which approximate tension on the rope based on the load on the tugger motor). A 7/8" nylon pulling rope was used. Anticipating that these pulls would likely be more severe than most real-world installations, the rope was attached to the aluminum conductors directly, after stripping back the insulation enough that the insulated conductors could enter the conduit on a staggered basis. The entire pulling head was wrapped in duct tape to protect the conduit from the bare metal.

The load cell was used to monitor and record the tension on the rope throughout the pulls; from the time the pulling head first entered the conduit to the time it emerged from the conduit at the other end of the pull. An instantaneous reading of tension was recorded once per second for the duration of the pull. As the duct-taped head was pulled through the elbows and sweeps, "spikes" in the readings were observed. The data was plotted, and all readings for the duration of the pull were averaged and reported as "average pulling force" for the pull. The average tension for the pull gives a good indication of the pulling performance of the cables during this case study.

Test pulls were made for three separate situations and one control. Each pull scenario consisted of a minimum of six pulls to provide enough data for a normal distribution. After each pull, the conduit was replaced with new clean conduit. First a control pull was made with a standard LLDPE jacket. To hold to standard practices in the field the head and cables were lubricated by hand at the entrance to the conduit, per manufacturer's specifications. The lubrication used in all test pulls was Polywater® Lubricant J. Next, the new PowerGlide™ MV cables were pulled without any lubrication. The PowerGlide™ MV cables were then pulled with lubrication in the same manner as the first series of pulls. Finally, the PowerGlide™ MV cables were pulled while only lubricating the head and the first ten feet of cable past the head. These different series of pulls were designed to model real world possibilities for use of the PowerGlide™ MV cable.

Discussion of Results

The PowerGlide™ MV jacket performed well in a lab setting, when compared with a standard LLDPE jacket. The results of these tests are listed below in Table 1. Each of these results represents an average of three tests.

Description	COF
Control NonLubricated	0.27
Control Lubricated	0.14
PowerGlide™ MV NonLubricated	0.14
PowerGlide™ MV Lubricated	0.13

Table 1: Results from Lab Coefficient of Friction Test

As shown in the table above, the PowerGlide™ MV nonlubricated performed as well as the control cable with lubrication applied to the cable at the entrance to the conduit. As expected, the coefficient of friction of the PowerGlide™ MV cable was further reduced when lubrication was applied at the entrance to the conduit.

This lab test alone would not be sufficient to prove the performance of the PowerGlide™ MV cable. We decided to setup an extremely hard pull in the field and have a crew pull the cables in during a series of field tests. Modeling this test after the lab tests, we needed a baseline to compare. It was decided to pull a lubricated control cable in first. Next we pulled in PowerGlide™ MV nonlubricated, then lubricated. We also pulled in PowerGlide™ MV while only lubricating the pulling head. Data was collected for six pulls and an average pulling tension was calculated. This data is located in Table 2 below.

Description	Average Pulling Tension	Tension Reduction
Control Lubricated	1412 LBS	
PowerGlide™ MV NonLubricated	1260 LBS	10.8%
PowerGlide™ MV Lubricated (Head Only)	1075 LBS	23.9%
PowerGlide™ MV Lubricated	987 LBS	30.1%

Table 2: Average Pulling Tensions for Field Tests

Notice in the table above, the PowerGlide™ MV performed better than the control in all three cases. Notice that the improvement column of Table 2 above is a comparison of the PowerGlide™ MV pull scenario to the lubricated control. In all scenarios, the PowerGlide™ MV outperformed the traditional LLDPE jacket. Field applied lubrications tend to settle out in the lower spots and wear off during a longer pull, whereas with the PowerGlide™ MV, lubrication stays with the cable during the pull.