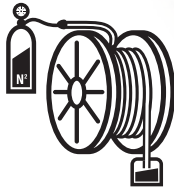




EDITION 10
VOLUME 1



7

FACTS YOU SHOULD KNOW

ABOUT SOUTHWIRE'S NITROGEN PURGING SERVICES

Written by Dr. Yuhsin Hawig, VP of Applications Engineering and Mark Dulik, Principal Applications Engineer & Certified Cable Splicer



RESPOND

Respond to unforeseen water penetration in new cables during storage or installation of commercial, industrial, or utility projects.



REVIEW

Review purging status by using moisture indicators to make GO vs. NO-GO decisions.



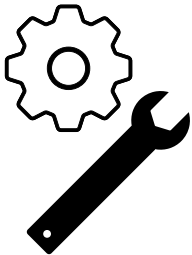
RECTIFY

Rectify single conductors, parallel or multiplexed cables, 600V building wires or medium voltage power cables, PV wires or wind farm primary concentric neutral cables, armored or unarmored cables, shielded or unshielded tray cables, and more.



REDUCE

Reduce material scrap by successfully drying out water in conductors or moisture transmitted along the cable length under the overall jacket.



RESTORE

Restore wet cables in the field due to unprotected cable ends or damaged end seals using a custom-built unit with step-by-step instructions, and the engineering knowledge to conduct the purging process easily and effectively.



RESULT

Result in minimum project delays and avoid extra expenses to replace brand new but wet cables.



REMOVE

Remove moisture or water by purging cables using dry nitrogen under pressure for hours or several days depending on the cable design, length, and the degree of exposure.





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VOLUME 1

15 THINGS TO KNOW ABOUT

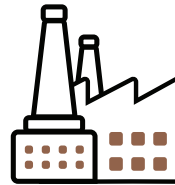
SUSTAINABLE ATTRIBUTES AND PRODUCTS

WRITTEN BY: Dr. Yuhsin Hawig, VP of Applications Engineering | Erika Akins, P.E., Applications Engineering Manager



DELIVER POWER RESPONSIBLY

Southwire is committed to providing the highest quality products and we are dedicated to protecting the well-being of our communities and the environment. The life cycle of products is scrutinized from the extraction of raw materials, manufacturing processes, designs, code & standard compliance, installation efficiency, performance, to the energy consumption and the final disposal. We lead the deployment of renewable technology to achieve zero carbon. We also reinforce the electrical grid to withstand more frequent occurrences of extreme weather as a result of climate change.



MANUFACTURING & ASSEMBLY

Southwire has invested in multi-year modernization projects to make a 70-year-plus company sustainable for the next 100 years. During manufacturing & the final assembly of finished goods, we seek every opportunity to reduce hazards, which can be anything that poses a threat to the safety and the health of workers or the environment. Removing waste and recycling scrap to attain the best output have been the top priority for decades. We put heavy emphasis on economically-sound processes that are vertically integrated to conserve energy as well as natural resources to make each product.



**STRONG.
SUSTAINABLE.
SOUTHWIRE.**

5 ATTRIBUTES OF SUSTAINABILITY

Many organizations around the world define sustainability differently as there are goals

and governance that are more important to a specific industry. This engineering whitepaper outlines five critical attributes which span the entire product life cycle and enable Southwire to innovate and to offer sustainable solutions. These products can be implemented in more than 10 diverse applications including data centers, utility, mass transit, factory automation, renewables, telecom, healthcare, automotive electric vehicles, ports & terminals, residential, and commercial buildings.



INSTALLATION

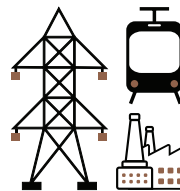
Once the wire and cable products are delivered to the job site, they will be unloaded, unreeled, pulled, bent, and laid at the final destination. Every step of the way could be labor-intensive, time-consuming, and error-prone to trigger severe physical damage to products and cause injuries if not handled appropriately. Safer, more ergonomic, and more effective installations can be executed by reducing hazards or waste, renewing packaging or reel handling systems, raising flexibility, reducing pull tension, and more. Southwire has sold many patented inventions that yielded sustainable installations globally.



RAW MATERIALS

Sustainable materials can be achieved by creating safer chemical formulations with less hazardous

substances to lessen the environmental footprint or with "Living Building Challenge Red List" approved compounds to prevent serious risks to human health. It can also be accomplished by adopting renewable energy, such as solar, to power raw material productions. Furthermore, increasing the recyclability of all components and upgrading packaging designs are commonly utilized. Finally, sustainable procurement, which integrates social, ethical, and environmental requirements into the qualification of suppliers is a must.



USE PHASE

Multiple factors will determine the sustainability of wire and cable products after the system has been energized. Firstly, using sustainable materials designated low-smoke and/or zero-halogen reduce hazard that compromises the health, safety, and the environment. In the event of overheating due to short-circuit or fire, these products generate fewer toxic gases. Secondly, products can be designed to carry a greater ampacity with less energy loss. Lastly, these products can also boost grid resiliency in case of natural disasters such as hurricanes or severe environmental conditions such as corrosive saltwater, heavy UV rays, or wildlife attack.



Southwire®

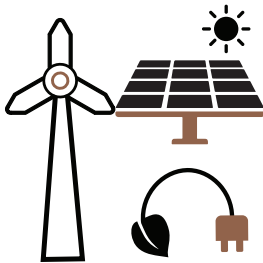
15 THINGS TO KNOW ABOUT

SUSTAINABLE ATTRIBUTES AND PRODUCTS



END OF LIFE

The wire and cable products manufactured today can achieve an average life of 40 years if designed, installed, and operated properly. Using ruggedized systems can extend the ultimate service life, which, in turn, delays replacement. A shorter downtime and less likelihood of worker injuries during cable replacement should be considered. Southwire offers field repair and cable rejuvenation services to further extend the life of cables. When aging assets need to be disposed of, better recyclability can be found on cables extruded with thermoplastic or non-crosslinked insulations and jackets or conductors containing a single metal instead of mixed metals.



SUSTAINABLE PRODUCTS

Southwire offers over 180 different sustainable products and many of those are deployed specifically for the explosive growth of renewable industries including electric vehicle (EV), wind and solar power, battery energy storage systems (BESS), and mass transit. Our sustainable solutions can also be seen at residential homes, commercial developments, industrial and OEM applications, as well as utility grid projects. This technical document showcases six product examples, and more can be found on the Southwire website. [CLICK HERE TO VIEW.](#)



MCAP[®] TYPE MC ALL PURPOSE CABLES

MCAP[®] Type MC Cable was invented based on electricians' feedback to reduce terminations per box and to declutter the wiring. Therefore, this is one of the best examples of a sustainable product due to user advantages during installation. These include simplifying grounding connections with fewer parts, boosting grounding reliability with the patented integral ground laid under the armor, and less mechanical connections. Eliminating one termination in every outlet with less room for error and cutting up to two minutes of installation time per connection could lower the overall project cost by up to 50%.



SIMpull[®] COILPAK[™] WIRE PAYOFF AND SIMpull BARREL[™] CABLE DRUM

A SIMpull[®] CoilPAK[™] Wire Payoff paired with a low-friction SIMpull THHN[®] wire is sustainable as it lessens the physical burden of material handling with a major reduction in pulling tension. It is a space saving design when bundling multiple wires in a single package. SIMpull Barrel[™] Cable Drums allow branch circuit installations to be completed with the utmost safety and productivity. No need to worry about broken reels, flanges, or torn arbor holes. A variety of products can be shipped in SIMpull Barrel[™] Cable Drums including type MC cables. The drum holds longer lengths, which shortens time to change over and reduces wire remnants on site.



EV CHARGING

With a growing interest in clean energy coupled with the advancement of lithium battery production, electric vehicle adoption for residential, commercial, and government entities is happening at a record speed. The rapid EV expansion can also be attributed to the investment in building out the grid infrastructure through Electrify America and the Bipartisan Infrastructure Law (BIL). Southwire's EV charging cables, building wires, and medium voltage cables that power the pedestals play a critical role in the supply chain to fulfill the enormous demand in the years to come. These products to support EV are sustainable due to the reduction of greenhouse gas emissions from transportation.

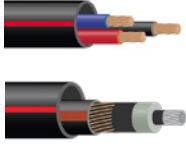


LOW SMOKE ZERO HALOGEN (LSZH)

Safer and environmentally friendly modes of public transportation are a necessity as urbanization stresses existing traffic corridors. Heavy smoke and toxic gases are harmful, making low smoke zero halogen (LSZH) materials the best choice for public safety in the event of a fire in less ventilated spaces such as tunnels used for mass transit. LSZH designs are commonly specified for manholes and underground installations located in densely populated areas. Southwire's sustainable SOLONON[®] LSZH and SOLONONplus[®] LSZH product lines include XHHW-2, RHH/RHW-2, traction power cables, medium voltage cables, as well as multiconductor tray cables with an overall LSZH jacket.

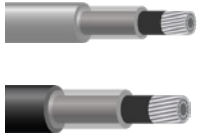


15 THINGS TO KNOW ABOUT SUSTAINABLE ATTRIBUTES AND PRODUCTS



SIMpull® CABLE-IN-CONDUIT (CIC)

In recent years, widespread power outages caused by natural disasters have expedited the hardening of our electrical grid. This can be accomplished in several ways. One is to convert critical overhead lines to below grade networks either by using cable-in-conduit (CIC) or ruggedized underground cable constructions. Pulling a single reel containing cables protected by a durable high-density and halogen-free polyethylene (HDPE) duct not only saves labor and reduces installation time, but also prevents field injuries due to material handling. CIC is sustainable because it is safer than direct burying cables and it also extends life, lowers cable replacement frequencies, and shortens outage duration.



TREE WIRE (COVERED CONDUCTOR)

Tree wires are sustainable alternatives compared to bare conductors as the added covering improves resiliency of overhead lines in tree crowded areas prone to major weather events including storms and wildfires. The robust covering can prevent direct shorts and instantaneous flashovers when tree limbs or other objects such as wildlife contact conductors in close proximity. The abrasion, track, and UV resistant high-density crosslinked polyethylene (XL-HDPE) outer layer minimizes power outages and sparks due to conductor slapping during windy conditions. Tree wires or covered conductors require less frequent tree trimming compared to bare their overhead counterparts.



Southwire

CABLETECH SUPPORT™

Services

CABLETECHSUPPORT™ SERVICES

Southwire's CableTechSupport™ services offer many reference documents and whitepapers to help end users with the selection of products for the most challenging applications. Our Re3™ mission statement, is based on sustainability: to design Reinforced, Resilient, Reliable products and provide services to Respond, Rectify, and Restore. You can access the publications directly from the website. **CLICK HERE TO VIEW.** We have a track record of successful custom engineering solutions and, not only meeting sustainable criteria, but also exceeding long-term electrical, thermal, mechanical, and environmental performance.



Southwire®



EDITION 17

VOLUME 1

20 BEST PRACTICES TO FOLLOW DURING CABLE INSTALLATION

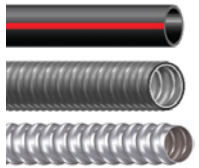
WRITTEN BY: Dr. Yuhsin Hawig, VP of Applications Engineering | Mark Dulik, Principal Engineer & Certified Cable Splicer



PURPOSE OF CONDUIT

Many methods can be deployed to install electrical wiring, including cable trays, conduit, messenger support systems, duct banks, or direct burial. This engineering whitepaper focuses on cable installations via conduits and

lists critical guidelines to follow to complete projects safely and effectively. The purpose of placing cables within conduits is to provide a barrier both electrically and physically to prevent electrocution and shield cables from mechanical forces. Conduit installations have been successful in data centers, power generation, industrial factories, manufacturing, oil & gas, commercial projects, utility grid hardening, and more.



CONDUIT TYPES

There are many different types of conduit in the electrical industry. Conduit selection depends not only on the location (for example: above or below grade) but also on code & standard

requirements, budget restrictions, and whether it is a residential, commercial, industrial, or utility project. Electrical Metallic Tubing (EMT), Rigid Metal Conduit (RMC), and Flexible Metal Conduit (FMC) are the most common metallic ducts. Flexible HDPE & Rigid PVC conduit are the most frequently used materials made of lightweight plastics. Composite conduit containing fiberglass is also available in the marketplace. There are pros & cons for each option, and it is important to consult with conduit vendors to specify the design based on each unique project.



DIRECT BURIAL & BACKFILL

Cables installed in HDPE conduits are designed for below grade locations, which can be direct buried in earth or encased in concrete. HDPE ducts can be installed for aboveground use only if the conduit is encased in no less than 2 inches of concrete. Minimum cover requirements for burying both HDPE & PVC conduit per NEC® depend on circuit voltage ratings. 18 inches of cover is needed for circuits rated 15 kV or lower, and 24 inches of cover is a must-have for 35 kV circuits. A smooth, leveled trench ground plane is essential to prevent conduits from being punctured by rocks or sharp objects. If the natural soil on site is too rocky or has a very high thermal resistivity, then engineering backfill with a better thermal conductivity should be utilized.



EXISTING CONDUIT CLEANING

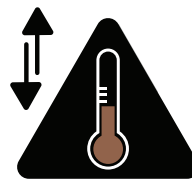
If existing conduit is to be re-used, conduit cleaning and proofing should be considered. Conduit should be cleaned out thoroughly by carefully scraping the internal conduit walls with brushes and mandrels designed for the specific conduit material. It is important to ensure that conduit is free from debris and foreign matter. Test balls

can be pulled through conduits to verify that the conduit is not physically deformed or crushed. It is not uncommon to find aged ducts with an oval shape or partially collapsed walls. In those cases, replacement of damaged conduits is recommended for the safety and long-term reliability of the electrical wiring system.



LOW AMBIENT TEMPERATURE

Low temperatures are a cause for concern when installing cables. Cable should be handled with extra care and pulled more slowly using larger sheaves during cold weather. If cables must be installed in freezing conditions, they should be placed in a heated area such as an indoor warehouse for at least 24 hours immediately before installation. Cables containing a PVC insulation, a PVC jacket, or both should not be handled or pulled at ambient temperatures lower than -10°C or 14°F due to brittleness which triggers cracking. Cables containing a CPE insulation or jacket should not be installed below -20°C or -4°F. Other cable types such as XHHW, XLPE, or PE have a minimum installation temperature of -40°C or -40°F.



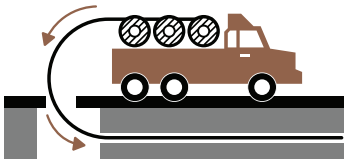
EXTREME TEMPERATURE SWINGS

In climates where there are large intermittent or seasonal temperature swings, jacket shrinkback can occur at splices and terminations allowing entry of moisture and contaminants into the cable. This is due to a ratcheting effect associated with the expansion and contraction cycles of the cable. At these sealing points, using mechanical restraints, shrinkable sleeves, or electrical tape are effective ways to restrict the jacket movement due to thermal cycling.



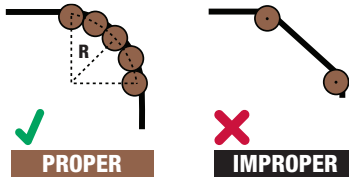
20 BEST PRACTICES TO FOLLOW

DURING CABLE INSTALLATION



UNDERGROUND DUCTS

For pulling cables into a below-grade conduit, the curvature of the cable feed should be a continuous smooth arc. This can be accomplished by using appropriate feeding sheaves, flexible feeding tubes, or automatic cable feeding machines.



CABLE SHEAVES

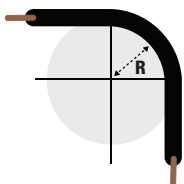
On cable pulls pulled by hand or with pulling machines, sheaves are placed at the entry of the pull to eliminate sharp bends and guide the cables into the duct to eliminate damage. It is a good practice to have personnel oversee the cable entry and ensure cables are entering conduit straight, without twists or sharp bends. Sheaves are also used for direction change in a cable pull; pull tensions and minimum bend radius should be observed at these points to avoid cable damage and personal injury. There are a variety of sheaves available to fit your specific cable pull.

PULLING LUBRICANT



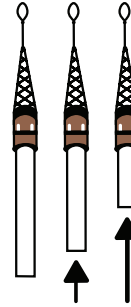
Pulling lubricant is applied to the cable surface prior to installation to reduce the coefficient of friction. The chemical compatibility of the lubricant with cable and conduit is extremely important.

We recommend only using a cable lube brand that has been tested per IEEE 1210. The lubricant should not have any detrimental effects on the conduit or on the physical or electrical properties of the cable insulation, semiconducting, or jacket materials. The lubricant should not compromise the performance of the cable per thermal ratings, flame propagation, oil & sunlight resistance, or other UL or CSA listed markings.



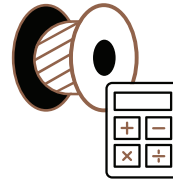
MINIMUM BENDING RADIUS

A non-shielded and non-armored cable can tolerate a sharper bend than a shielded or armored cable. When bent too sharply, the metallic component such as helically applied copper tape can separate, buckle, and cut into the insulated cable core. Therefore, the minimum bending radius for a single conductor with a metallic shield is 12 times the cable radius compared to 8 for unshielded designs. The minimum bending radius for interlocked armored cables is 7 times the cable radius.



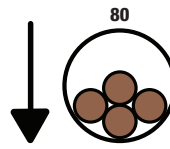
ALLOWABLE TENSION ON PULLING DEVICE

Do not exceed the allowable tension stated by the manufacturer of the pulling eye, 10,000 pounds, whichever is less. Traditional conservative practices limit the allowable tension of a basket grip to 1,000 pounds. Under specific conditions, this limit can be safely exceeded.



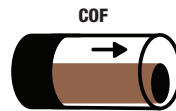
MAXIMUM PULLING TENSION

The conductors of the cable are generally the only component that can bear the pulling forces without being damaged. Do not use metallic shielding wires, tapes, braids, or armor not designed for the purpose of pulling tension calculations or pulling. For fully annealed soft drawn copper, the maximum pulling tension or allowable conductor stress is 8 lbf (pound-force) per kcmil. For example, 500 kcmil copper single conductor, 4000 lb (500 kcmil x 8 lb/kcmil) is the maximum allowable pulling tension. For power cables containing 8000 or 1350 3/4 hard stranded aluminum conductors, the maximum pulling tension is 6 lbf (pound-force) per kcmil.



PULLING TENSION DERATING

Pulling between 1 to 3 conductors at the same time does not require a pulling tension derating. However, if four or more conductors paralleled or multiplexed, are being pulled together, the maximum pulling tension should be lowered with a derating factor of 80%. For example, pulling four 500 kcmil copper conductors will yield a maximum pulling tension of 12,800 lb (80% x 4 x 4000). Pulling mixed cable sizes needs to be handled with extra care. Using the lowest maximum pulling tension or the value from the smallest conductor for calculations with a conservative derating factor of 75% is recommended.

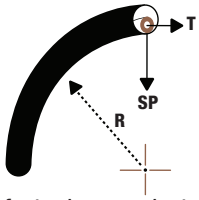


COEFFICIENT OF FRICTION (COF)

The coefficient of dynamic friction is a measure of the frictional force between a moving cable and the duct. It can vary from 0.1 to 1.0 with lubrication and can exceed 1.0 for unlubricated pulls. Exterior cable material based on PVC, Nylon, PE, XLPE, LSZH features a COF of 0.35 in a PVC or HDPE plastic conduit. Cables containing CPE exhibit a higher COF of 0.5 in the same plastic conduit. Pulls should never be stopped and restarted because the static COF will always exceed the dynamic COF. Higher ambient temperatures (80°F & above) can increase the COF for cables with a non-metallic sheath.

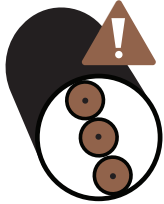
20 BEST PRACTICES TO FOLLOW

DURING CABLE INSTALLATION



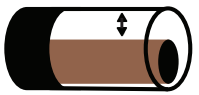
SIDEWALL BEARING PRESSURE

Sidewall bearing pressure or sidewall pressure (SWBP or SP) is exerted on a cable as it is pulled around a bend. Excessive sidewall pressure can cause cable damage and is the most restrictive factor in many installations. A maximum sidewall pressure of 1000 lbf/ft is recommended for utility primary & secondary products (600 V- 46 kV), industrial power & control cables (300 V-35 kV), and building wire single conductors sized 8 AWG & larger. For building wire single conductors sized 14, 12, and 10 AWG, we recommend the maximum sidewall pressure of 500 lbf/ft.



JAMMING RATIO & PROBABILITY

Jamming is the wedging of three or more cables when pulled into a conduit. This usually occurs because of crossovers when the cables twist or are pulled around bends. The jamming ratio (D/d) can be determined by dividing the conduit inner diameter (D) with the cable outside diameter (d). In calculating jamming probabilities, a 5% factor is used to account for the oval cross-sectional area of the conduit bends. The cable diameters should be measured since actual diameters may vary from the published nominal values. Jamming probability can be lowered by changing the conduit size or by pulling plexed cable assemblies rather than parallel cables. Jamming occurs when the jamming ratio falls between 2.8 and 3.2.



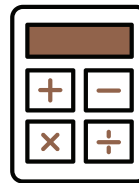
CLEARANCE

Clearance is the distance between the top of the uppermost cable in the conduit's and the inner top surface of the conduit. It should be at least 10% of the conduit's inner diameter or at least one inch for large cables or installations involving numerous bends.



CONDUIT FILL

Conduit fill is the percentage of the area inside the conduit taken up by the cable(s). Per Table 1 (Percent of Cross Section of Conduit and Tubing for Conductors and Cables) in Chapter 9 from NFPA 70®, National Electrical Code® (NEC®), a maximum conduit fill ratio of 53%, 31%, and 40% are recommended for one, two, and three or more conductors, respectively.



PULL CALCULATIONS

Southwire's CableTechSupport™ Services offer comprehensive cable pulling calculations for existing customers. The online calculator, available on Southwire.com, is free of charge and can be accessed by any user. We recommend conducting pull calculations in advance to evaluate the entire cable route, coefficient of friction for different jacket materials, pull distance, the number of bends, as well as the angle of each bend.



CABLETECHSUPPORT™ SERVICES

All conduit installs regardless of material types should follow NFPA 70®, National Electrical Code® (NEC®), or NESC® (National Electrical Safety Code®). Southwire's CableTechSupport™ Services offer many reference documents and engineering whitepapers to assist you with code & standard compliances for any challenging project. You can access the articles directly from the website below: [CLICK HERE TO VIEW](#)

We also offer over *10 free calculators online and apps* to download. [CLICK HERE TO ACCESS CALCULATORS/APPS](#)