EDITION 15
VOLUME 1

15 TOP FACTORS IMPACTING

THE SERVICE LIFE OF WIRE AND CABLE PRODUCTS

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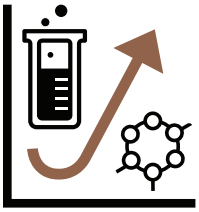
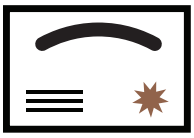


TECHNOLOGY ADVANCEMENT

When extruded dielectric cables were first introduced in the 1960s, the industry experts expected the cables to operate reliably for less than 20 years. The advancements in polymer formulation, reinforcing additives, crosslinking chemistry, raw material cleanliness, compound handling, and extrusion equipment have improved the quality and the performance of insulated cables significantly in the past decades.

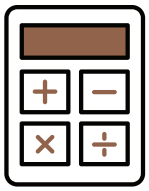


40-YEAR LIFE EXPECTANCY

The wire and cable products manufactured today can achieve an average life of 40 years if designed, tested, installed, and operated appropriately. The industry in general agrees that no scientific principle or official test method exists today to determine the true life of any wire and cable products. However, factors included in this document can be used as a check list to boost the resilience and the reliability of the electrical cable systems and in turn, extend the expected life.

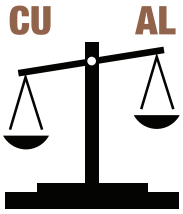
CUSTOM DESIGNED PER CODES AND STANDARDS

Cable designs shall meet the latest industry codes and standards, which include ASTM, ICEA, AEIC, IEEE, UL, CSA, CANENA, NESC, NEC, etc. The materials designated should be suitable for the environment that the cables will be operated in. Many product variations made of vastly different materials can meet the same industry standard and can be used interchangeably for the same application. Thus, simply referencing a published standard might not be sufficient. Southwire's CableTechSupport™ Services team can help to custom design the conductor, insulation, shielding, optional cable components, and jacket material, as well as markings or ratings for the overall cables to meet or exceed every aspect of the operation.



MULTIPHYSICS CALCULATIONS

For overhead applications, sag and tension calculations for MV tree wire (covered conductors), 600V service drop, and transmission conductors are the key to creating the most ruggedized line design. For undergrounding, voltage drop, conduit fill, jamming ratio validations, cable pull, and short circuit calculations are performed during the project design phase to achieve the most resilient system. The complimentary multiphysics modeling and calculations offered by Southwire help end users to choose the most suitable wire and cable designs for a prolonged life.



CONDUCTOR VS. AMPACITY

Many projects in recent years specify copper (Cu) instead of aluminum (Al) conductors due to the highest ampacity required for the explosive growth of power demand due to electrification and digital transformation such as renewable energy, EV, and data centers. Both Cu and Al conductors can achieve similar performance and sustain a long life. Southwire offers comprehensive ampacity modeling using multiple software tools to ensure that the maximum current carrying capacity for 600V and medium voltage cables under complex installation configurations and unique ambient conditions is adequate.

DIELECTRIC MATERIALS

The dielectric materials to manufacture power or control cables including semiconductive shields, insulation, and jacketing compound are the most critical components to obtain a long service life. Thermoplastic or Thermoset formulations can be selected for overhead or underground applications depending on the continuous operating temperatures. The crosslinked chemistry with a superior thermal stability and enhanced physical and chemical properties are specified by utility and many demanding industrial systems where emergency overload and short circuit events occur more frequently.

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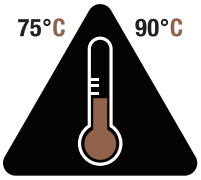
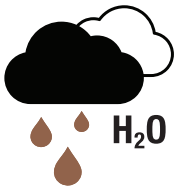


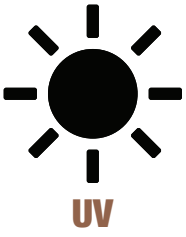
THERMAL STABILITY AND TEMPERATURE RATING

For 600V cables and covered conductors, normal operating temperature is the highest allowable temperature that may be attained by the hottest portion of a cable line during daily load cycles. Thermoplastic insulation or covering is designed for 75°C normal operation, 95°C emergency overload, and 150°C short circuit temperatures, respectively. Thermoset or crosslinked insulation or covering can sustain a higher temperate rating of 90°C normal operation, 130°C emergency overload, and 250°C short circuit temperatures, respectively. When adequate knowledge of the thermal environment of the cable is lacking, the permissible conductor temperature should be reduced by 10°C.



WATER INTRUSION AND CORROSION

Water intrusion and metallic corrosion are undoubtedly the top root causes for cable system failures. Water penetration can occur in new cables during storage, transit, or installation. Water accelerates dielectric breakdown of insulation and triggers corrosions of conductor and shielding. More corrosion-resistant conductor designs such as solid stranding and tin-coated copper materials have proven to be effective. For underground medium voltage cables, it is also common to include a water-blocking compound or strandfill within the conductor. Water-blocking powder can also be applied over the shielding under the jacket to minimize the longitudinal water penetration along the installed length. We recommend performing field testing if cables might have water damage.

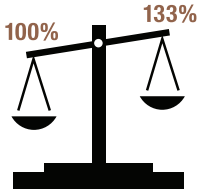


SUNLIGHT AND WEATHER RESISTANCE

Color fading on cables is normal, and it is frequently seen on cables installed in aboveground locations that are exposed to high levels of UV radiation. Faded color does not always correlate to dielectric breakdown. In fact, industry standards do not require an insulation or a jacket material to retain its original color as a prerequisite for sunlight or weather resistance. UV degradation of insulated cables or covered conductors is one of the most common failure modes for aboveground installs. We do suggest that the end users increase the frequency of routine inspection of cables exposed to severe UV coupled with harsh environmental conditions such as saltwater and extreme temperature fluctuations.

LOCATION AND ENVIRONMENT

Many different products can be used for the same application and the decision depends heavily on the unique project location. Long-term exposure to harsh conditions such as high saltwater contents in the coastal areas and corrosive pollutants can jeopardize the service life of wire and cables. The impact of severe weather and natural disasters such as wildfire, hurricanes, lightning strikes, flooding, ice storms, earthquakes, and volcanic activities should be reviewed in advance during the design phase, so the most robust and ruggedized cable systems combined with proper accessories are sourced. Wildlife attack vs. protection on the electrical systems such as termites, birds, rodents, and snakes also need to be considered.



INSULATION LEVEL VS. ELECTRICAL STRESS

The cable insulation level is dictated by how fast the protective equipment can de-energize the electrical line in case of a fault. If a fault can be cleared within 60 seconds, then a 100% insulation is sufficient. However, if a fault will sustain beyond 1 minute, but less than 1 hour, then a 133% insulation is required. A 25kV 1/0 AWG cable with a 133% insulation yields a 15% reduction in electrical stress at the conductor shield and insulation interface compared to the cable with 100% insulation. Additionally, a heavier insulation thickness is recommended for systems prone to electrical surges. Lowering electrical stress of an insulated cable system is proven to extend the life expectancy.

SHIELDING DESIGNS

A variety of shielding designs for 600V/1kV, 2kV, and medium voltage cables can be customized to pair with different insulation and jacketing materials to deliver the best electric & magnetic field (EMF) mitigation or short circuit current protection. Copper concentric neutrals continue to be the most standard shielding design for 15-46kV underground utility cables compared to tape shield for industrial power applications. Longitudinally-applied corrugated copper tape shield is specified not only for MV cables but also 600V substation control cables as it creates an added physical and mechanical barrier to cover the circumference of the cable cores.

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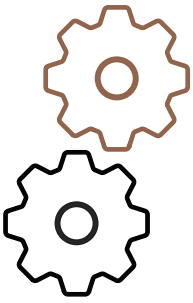
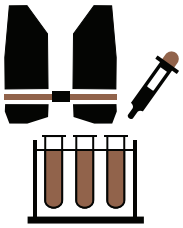
ACCESSORIES AND INSTALLATION

Selection of proper accessories to match the cable is as essential as the cable design itself. Verifying the accessory material, type, and size to make sure that it is fully compatible with the cable is a must. It has been reported that majority of the field failures are due to poor workmanship during terminating and splicing. Therefore, following the step-by-step instructions per the installation procedure from manufacturers is of critical importance. The use of proper tools to strip back insulation or to remove jacket can eliminate the creation of high electrical stress points, which could induce the dielectric degradation of insulation materials.



OPERATION AND MAINTENANCE

Commissioning testing is conducted often on critical circuits as it validates that the installed cable and accessory are free of defects, and it provides assurance for long-term performance. Recording the baseline measurements is beneficial for future evaluation of remaining life. In case of sustained overvoltage or overcurrent events, due to severe weather for example, a diagnostic protocol such as Insulation Resistance (IR), Partial Discharge (PD), or Very Low Frequency Tangent Delta (VLF TD) can be deployed in the field per IEEE 400 to assess the condition of an aged cable system. If it is determined that the cable systems have deteriorated beyond repair, then a prompt replacement should take place to prevent extended power outages.



UNDERGROUND CABLE REJUVENATION

Southwire's Novinium Underground Services offers an innovative reliability program and features a 30-year track record of deploying patented rejuvenation technology to extend the ultimate life of underground cable systems. More than 300 utility customers around the globe have successfully eliminated 660,000 metric tons of CO_2 as a result of successful rejuvenation of 150 million feet of field aged cables.

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