



Power Cable Testing

An Online Continuing Education Course for Engineers

Course Number: E-3075

Credit: 3 Hours / 3 PDH / 3 CPD

Power Cable Testing

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Visual inspection of the cable installations, conduit, manholes, and so on, and electrical maintenance testing are the major maintenance routines for cable systems.

Visual Inspection

Visual inspection can be completed on energized installations. However, if cables are touched or moved they should be de-energized. Cables in vaults, substations rooms, manholes, and at other areas need to be inspected on a yearly basis. This inspection needs to include:

1. Oil leaks, soft spots, and insulation swelling
2. Physical damage, sharp bends, and excessive and prolonged tension
3. Cracked jackets of non-leaded cables
4. Poor earth connections, metallic-sheath bonding deterioration, corroded cable supports, and continuity of main earthing system
5. Soft spots in terminations and splices
6. Corona tracking
7. Potheads should be inspected for oil or compound leaks
8. Inspect the manhole for spalling concrete and standing water

Aerial cables need to be inspected for mechanical damage that is made by vibration or deterioration of support and suspension mechanism. Inspection needs to be made of cables for insulation abrasion and cable being bent or pinched.

Cable Failures and Their Assessment

Power cables can get damaged due to many reasons. Some of the typical reasons are presented below.

Mechanical Issues

Mechanical issues can happen due to breaks and problems of sheath material, mechanical punctures by people or heavy machines, or cracks due to sharp bending or vibration. Regardless of the mechanical damage that happens in the cable sheath, the entrance of moisture will start slow deterioration of insulation material which will finally end in cable failure. Hence, it is important to protect the cable either from direct or indirect mechanical damage. This can be eliminated or minimized by proper selection, installation, and maintenance of power cable systems.

Sheath Corrosion

Sheath corrosion can happen due to the following factors:

- Acidity and alkali in conduits
- Dissimilar soil issues
- Soil chemical contamination
- Galvanic issues

Sheath corrosion will allow moisture to enter the insulation system and cause eventual damage. Sheath corrosion can be avoided by proper usage of cathodic protection, application of insulating paints, ensuring proper drainage, and removing chemical contamination source.

Moisture in the Insulation

Moisture entrance into the insulation system will deteriorate the power cable, and all precautions have to be taken to stop such entrance. Damage due to moisture can be discovered by the following symptoms:

- Whitish powder on aluminum conductor
- Resistance to tearing of tapes
- Bleached or soggy paper
- Visible water
- Stain on the inside surface of the sheath

Cable Heating

Increased heat rise in the cable will cause insulation degradation. Heat can be caused by overloading, increased ambient temperatures, insufficient ventilation, manual heating due to cables being installed too close to each other, or external heat sources. Attention needs to be taken not to surpass cable insulation system temperature. This can be accomplished by first identifying the different environmental and operating factors that will affect the proper selection of the cable insulation and conductor size. Once correct selection and installation are done, routine cable maintenance and inspection will ensure safe and long service.

Fire and Lightning Surges

Fire in conduit or manholes can cause cable damage and failure in adjacent manholes and junction boxes. Barriers can be placed between big groups of conductors to prevent fire damage. Lightning arresters need to be installed to protect the cable where it is connected to overhead lines to minimize cable failures due to lightning surges.

Electrical Puncture

Once the insulation is weakened due to any of the presented reasons, it may electrically fail. At the point, the insulation system cannot confine the electrical current flow to the conductor inside the insulation system. Failure may be line-to-earth or three line-to-earth or line-to-line faults. Apparently, if the failure is caused by a short circuit, it will be cleared by the circuit protective device. Some of the not-so-easy-to discover electrical failures can be:

- Lack of compound in the insulation
- Sheath bulging
- Polymerized compound (wax)
- Tree design marking

The cable failures can be further grouped into two classes as follows:

- Inherent causes
- Non-inherent causes.

Inherent Causes

Inherent causes can be organized as follows:

- Sheath or jacket issues
- Insulation failures
- Conductor failures

Sheath or Jacket Issues

Sheath issues happen due to:

- Eccentric lead thickness less than 85%
- Thin lead (splits under pressure)
- Cracked, embrittled, soft spots, bulge, cuts, bruises, or gauges
- Structural defects: radial splits, laminations and gas pockets

Insulation Failures

These failures happen due to the following:

- Workmanship defects. These can be detected by the following:
 - Soft walls
 - Torn tapes
 - Wrinkling or creasing of tapes
 - Knotted or misplaced fillers
 - Excessive registrations
- High dielectric loss. These can be detected by the following:
 - Can be discovered by PF at 60°C or higher
 - Scorching or carbonizing of paper
 - Happens in one or more areas
- Incomplete saturation. These can be detected by the following:
 - Paper is void of the compound
 - Scarcity of the compound in spaces between adjacent tape edges and surfaces

- Unstable compound. These can be detected by the following:
 - Apparent change in the compound
 - Wax, in case of mineral oil Ionization: These can be detected by the following:
 - Strings or flakes of darkened wax containing carbon
 - Carbonized paths (tree design)

Conductor Issues

Conductor issues can be detected by the following:

- Sharp corners
- Irregular strands
- Strands burrs
- Incomplete strands
- Poor brazing

Non-Inherent

Sheath corrosion
sheath weakness,

Electrical breakdown

- Negative potential
- Positive potential
- Chemical action
- Local galvanic action

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...tration of the sheath or

...can happen due to:

...colored red, yellow,

...thin white crystal