Cable Lore

ANACONDA

BY POWER CABLE ENGINEERING AND RESEARCH

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HOW TO TROUBLE-SHOOT A POWER CABLE

Stock power cables are manufactured to rigid specifications based on designs of proven reliability. Routine factory inspection tests, accepted by the industry, provide quality assurance and indicate that the product has been manufactured according to applicable standards and is of good workmanship.

The limits within each individual power cable constructions can perform satisfactorily have been well described both in company literature and industry standards: for example: IPCEA. Within statistical limits, it is reasonable to expect trouble-free service providing cable choice has been prudent and the cable manufactured to specification. Unfortunately, ideal conditions do not always exist throughout the cycle of cable choice, installation and application. Cable failures do occur; causes for failure must be determined and remedial action taken.

Generally there is an aura of mystery surrounding a cable complaint. The cause for failure is not immediately apparent. There is usually considerable inconvenience to a customer and a period of uncertainty affecting both the manufacturer and the customer. The wheels of a standard CCA go into motion and, after some duration, a settlement is reached. There is considerable merit in determining the cause for a cable failure as quickly as possible. Corrective measures to prevent repetition of failure can be taken immediately and ultimately the frequency of CCA's reduced to a minimum.

A review of cable failures by those directly involved in trouble-shooting and CCA's - both field and laboratory - reveal some enlightening facts:

(1) Cable failures that can be attributed to poor workmanship, or sometimes referred to as "defective cable," are in the small minority. Based on footage produced these would fall within predictable statistical limits.

(2) There is no mystery to the large majority of cable failures. Factors that are responsible for failures can be categorized, classical evidence observed, and a basis for remedial action presented.

The following Trouble-Shooting Guide has been prepared by the staff of Marion E & R. Judicious use of this guide can be valuable in quickly determining the cause for most classical type complaints. Especial attention and study should be given to the section on mechanical damage. This particular factor is probably responsible for more cable failures than all of the remaining factors combined.

POWER CABLE
(Trouble-Shooting Guide)

Factors That Cause Failure	Evidence	Key to Preventive Measures
Mechanical Damage	1. Kinked Conductors	A,B,C,D,E,F,G
	2. Torn Shields	G,H,I,J,K,L,M
	3. Jacket Cut	M,L,J,H,E,N,O,G
	(a) Puncture	
	(b) Knife-Type Cut	
	(c) Compression Break	
	4. Abrasion	P,Q,H,L,E,J
	5. Interior Compression Cut	R,S,T,T,V,C,E
	6. Compression Deformation	W,X,Y,G,C,U,V,T,E
	7. Cable Geometry Disturbed by Excessive Tension	Z,Z-1,O
	8. Jack-Knifed Shields	B,C,F,E,A,D,G

PREVENTIVE MEASURES

A- Pull cable from revolving reel; never from stationary.
B- Observe minimum bending diameters, both during installation and final training.
C- Avoid any type of impact, run-overs, etc.
D- Do not pry against cable to roll reel or while removing lagging.
E- Prevent overruns when de-reeling.
F- Remove all stples, nails, etc. from inner surface of flanges.
G- Use proper bedding and backfill.
H- Do not drag cable over sharp objects; for example: angle iron, duct mouth, etc.
I- Prevent torsion of cable during pulling.
J- Use sheaves of adequate diameter and clearance.
K- Use ducts, conduits of adequate size and bends. Z-1 - Apply lubricant.
L- Be sure ducts, conduits are properly aligned at joints.
M- Ducts and conduits must be clear of foreign materials and burrs.
N- Do not drive spikes or nails through reel flanges.
O- Observe maximum pulling tension.
P- Avoid dragging over ground.
Q- Rod duct.
R- Avoid excessive conduit fill, especially in bends.
S- Avoid excessive clamp pressure. Use clamps with adequate contact area.
T- Do not drop reels during handling.
U- Align reel flanges during storage to prevent bumping cables.
V- Store reels with flanges upright.
W- Use Kellems grips in suspension.
X- Do not touch cable with fork lifts or slings.
Y- Avoid cross-overs on direct burial.
Z- In direct burial leave sufficient slack in cable to accommodate soil shifting.
Z-1 Apply lubricant.

Factors That Cause Failure	Evidence	Preventive Measures
Termination Failure	1. Carbonization - Charred or Burned Insulation 2. End Flashover 3. Tracking - Narrow Channels of Burned or Charred Insulation 4. Treeing - Very Narrow Channels of Charred Insulation Resembling a Bare Tree - Usually with a Main Stem or Trunk with Side Branches 5. Corrosion of Soldered Joints in Shielding System 6. Swelling of Insulation 7. Deterioration of Termination Outer Covering 8. Shield not Grounded 9. Declining Megger Readings	All termination procedures must follow cable manufacturer's recommendations. Clean exposed insulation to maximum megger reading. Proper leakage distance. Frequent inspection of surface for contamination and deterioration. Periodic cleaning of pothead skirts. Solder joints must be of good workmanship. Prevent contact of insulation with oil or other deleterious materials. All potting materials should be chemically compatible and within temperature limitations of insulation. Proper selection of external covering materials. Frequent inspection. Shielding system must always be solidly grounded.
Excessive Temperatures	1. Hard Jackets 2. Porosity in Insulation 3. Cracked Jackets 4. Discolored Conductors 5. Loose Jacket and Insulation 6. Split Shielding 7. Melting of Insulation 8. Deformation 9. Declining Megger Readings	Keep within current ratings of cable for ambient conditions. Select cable for highest ambient on circuit. If potheads are used, care should be taken not to use indoor porcelains in outdoor applications. Plan ahead.

Factors That Cause Failure	Evidence	Preventive Measures
Corona	1. Erosion of Insulation 2. Blue Glow 3. Hissing Noise 4. Radio Interference 5. Odor of Ozone 6. Precipitation if Airborne Contaminants 7. Declining Megger Readings	Properly constructed stress-relief cones of potheads on all shielded cables. Adequate clearance between conductor terminal lug and ground. Critical evaluation of shielded versus nonshielded cables with IPCEA recommendations as guideline.
Ozone	1. Radial Cracks in Cable 2. Odor 3. Evidence of Corrosion on Metallic Objects in Vicinity	Avoid sharp bends. Adequate ventilation. Take adequate measures to prevent corona. Proper choice of 600-volt cables that are in circuit where ozone might be present.
Over-Voltage	1. End Flashovers 2. Pinhole Failures 3. Sequence of Pinhole Failures 4. Burnt-out 5. Treeing Within Insulation 6. Declining Megger Readings	Proper voltage rating of cable. Properly grounded lightning arrestors. Design system to minimize resonant conditions. Avoid excessive proof-test voltages.
Animal Damage	1. Teeth Marks 2. Dead Animals in Vicinity of Fault 3. Termites in Cable 4. Bacteria and Fungi 5. Birdshot	Armored cables for rats, gophers, etc. Copper shield for termites.
Chemical Environment	1. Excessive Swell 2. Discoloration 3. Hardening or Softening of Cable 4. Metal Corrosion	Proper cable selection for environment.

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