CATV SYSTEM GROUNDING TECHNIQUES

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Grounding and bonding are important to CATV operators for the protection of personnel and plant from accidental power line contact and lightning strikes. The increasing complexity of CATV systems and a growing use of buried plant, with its special susceptibility to lightning damage, should stimulate operators to analyze grounding and bonding needs beyond those historically established in joint-use and utilities codes requirements. The important aspects of these special grounding techniques are described in this paper.

Standards for bonding and grounding for CATV have generally been obtained from the National Electrical Safety Code, which was the result of work between the power companies and the communications companies. Since CATV is a communications industry, many of the requirements of the code can be directly applied to CATV, and have been in past installations. In the future, when CATV pole plant use grows to telephone plant levels in urban areas, the NESC will undoubtedly be modified to include more specific joint use requirements for CATV. In the meantime, it would appear desirable for the CATV industry to give some special attention, in the design of new systems, to the grounding problems which they will encounter in both joint use and on their own supporting structures.

It is the purpose of this paper to point out several of the items to be considered and the actions to be taken not only to conform to the requirements of the NESC but to properly protect CATV employees, subscribers, and the CATV plant where joint use may not be involved.

Coaxial cables for cable television use, consist of a center conductor, an insulating medium, and a cylindrical outer conductor on the same axis as the center conductor. The outer conductor of today's cables is usually made of aluminum and is frequently the exterior of the cable, unless the cable is jacketed with a sheath of polyethylene or some other plastic, or reinforced with an outer sheath and a steel tape or tapes for strength. The electrical impedance of the coaxial conductor is determined by the diameter of the center conductor, the spacing between this conductor and the outer conductor, and the thickness and diameter of the outer conductor. This is usually 75 ohms unbalanced to ground.

The ground serve not only as a base from which potentials are measured, but also provides a protective function in the event the coaxial cable is contacted by outside potentials.

As it is virtually impossible for CATV systems to avoid exposure of facilities to lightning strikes and occasional accidental power contacts, CATV system design engineers should be as meticulous in the drafting of grounding and bonding standards as they are in establishing system operational standards.

Cooperative and coordinated efforts with other users of distribution networks, such as the telephone and power companies, will provide protection against accidental contact with power circuits if all users adhere to accepted clearance requirements and other construction practices. We should, however, by a careful analysis of the type of network to be built, its location and the nature, and the type of joint users, set grounding and bonding standards which, in many instances, could be more stringent than the minimums placed on us as part of a pole attachment agreement or by a regulatory body order.

Before attempting to derive system bonding and grounding practices for a specific CATV system, one must first be aware of the nature of construction (aerial or buried) and our "right of way" neighbors' installations.

Looking first at the aerial possibilities, we see that we might find shared pole space with both power and telephone, with power alone, with telephone alone, or not shared at all if it is our own pole. For the underground, we might be using direct buried techniques or leasing existing conduit space on a shared basis with the telephone company. All of these possibilities present different grounding and bonding requirements, and should be so treated in drafting system construction practices.

Since television cables are communications conductors, and, if we assume the same standards apply to them as apply to telephone and telegraph cables, the configuration and many of the structural details, such as clearances and strength, have already been standardized in various codes and practices. Those are a result of long years of experience and study.

The grounding of television cables in each of the situations mentioned above will be discussed on the basis of the necessity to protect, as far as possible, against foreign potentials such as fallen power wire contacts or lightning resulting in injured personnel or damaged plant.

Case 1 - Where power, telephone and CATV share space on a pole the requirements normally found in our pole attachment agreements will be sufficient for system protection. The telephone company has already established an aerial communications plant that is effectively grounded and bonded to the multi-grounded network of the power company, in accordance with the requests of the NESC. By following the bonding and grounding requirements set forth in the attachment of renewal, the CATV system also achieves a satisfactory ground. However, when jacketed cable is used for the CATV system it should be noted that a low impedance bond or tie between the strand and the coaxial outer conductor must be maintained to avoid a "system contained" difference of potential as bonds to power networks are usually connected to the strand. With unjacketed cable, the lashing wire provides a continuous bond eliminating the need for further connections.

Case 2 - Where CATV and power share space without other communications lines being present, the CATV company, even if not required by the pole attachment agreement, should attempt to follow the pertinent sections for joint use of power and communications services set forth in the U. S. Department of Commerce, National Bureau of Standards Handbook 81, Part 2, "Safety Rules for the Installation and Maintenance of Electric Supply and Communications Lines" and the "National Electrical Code" published by the National Fire Protection Association.

Special safety considerations or cautions that should be exercised in this case, particulary where relatively inexperienced people are involved:

1. Always look for open or broken vertical ground wires before climbing the pole or commencing work. Any questionables wires should be checked with a voltage tester and if an excessive potential is noted, the power company should be notified.

2. All connections required to be made to the power company's network should be made by the power company, not by the CATV company.

3. Where suitable vertical ground wires exist, the CATV company may complete the connection between the strand and the ground wire but with the first connection being made to the strand. The use of rubber gloves is also recommended whenever work is being done on a joint use pole.

4. Whenever found, all street light fixtures mounted below or if in close proximity above the CATV attachment should be bonded by the power company to a vertical ground wire to which CATV should also bond.

5. The CATV strand should be bonded to a multi-grounded neutral supply system vertical ground wire at intervals no in excess of a ¼ strand mile.

Case 3 - Where telephone and CATV

are to share pole space without electrical supply lines, the CATV company should follow as closely as possible the practices set forth by the telephone company, particularly bearing in mind the following:

1. Where strand is not continuous (i.e. a dead end) a strand to strand bond should be installed and the bond connected to a vertical ground wire.

2. The strands should be bonded at all cross-overs.

3. The strands should be bonded and connected to the vertical ground wire at all power supply locations.

4. The strands should be bonded at intervals not exceeding 10 spans.

5. All guys should be bonded to the strands where the guy connection to the pole is made on a separate bolt.

Case 4 - Where a CATV network is installed on system-owned poles not shared with other users, standard telephone procedures for bonding and grounding non-joint use systems should be followed. Several of the more important of these practices are:

1. Strand supporting aerial plant should be effectively grounded at least once in every strand mile of system and at all power supply locations.

2. Where joint use crossing poles occur with electrical supply lines and communications lines, bonds should be made between the strands and the supply line neutral, which in turn should be connected to a vertical ground wire.

3. Where joint use crossing poles occur with only communications lines, bonds should be made between strands.

4. Grounds should be installed as close as possible to all strand dead end locations.

5. Strand continuity should be maintained throughout the CATV system.

6. At head end locations, the strand should be bonded both to the equipment rack and the tower ground.

One final caution for all aerial construction concerns the safety of employees while attempting to restore service after a major disaster. When plant damage is encountered, such as broken or burned joint plant caused by high winds, ice storms, collisions, or other disasters, no attempt should be made to restore the CATV cables until a survey of power contacts has been made, the contacts and reduced clearances referred formally to the power company, the power company has cleared them, and an inspection has been made to be sure they have been adequately cleared in at least a semi-permanent manner providing adequate strength and clearance. Only then should CATV personnel start to clear their plant.

While most of the television cables have been installed aerially, the increasing restrictions on aerial utility plant in most cities will probably mean that future cable television distribution systems will be underground rather than aerial, and it is highly probable that significant percentage of existing aerial plant will be replaced by underground plant in the future.

Underground cables can be placed either in conduit, or directly buried in the ground. Unless existing conduit runs are available, and can be leased from established carriers at reasonable rates, it will be found that the direct burial of television cables in most cases will be more economical. In either case, in conduit or direct burial, the need to prevent electrolysis indicates that the underground cables should have an insulating plastic sheath. As this jacket has a tendency to insulate the cable from ground special care should be taken to achieve the lowest possible impedance to ground throughout the system. Sheath continuity should be maintained to permit the distribution of foreign potentials over as much of the CATV system as possible.

Trunk amplifiers, line extenders, and other equipment having metallic cases which are connected to the grounded outer conductor should be grounded to the same extent as the television cable, whether they are buried directly or brought above ground in a pedestal for maintenance purposes. Special care should be taken at pedestal locations by attempting to limit any possible potential difference between the CATV system and other facilities that could be contacted simultaneously by employees, subscribers, or the public. Normal practice would be for the CATV system to bond to all other facilities or metallic structures at least within ten feet of the pedestal. Junctions of aerial and underground plant require additional engineering considerations but as there are several variables that could effect the bonding and grounding techniques, it would be too lengthy to go into here. Whenever a junction of this type occurs in a CATV plant it would be advisable to either research the requirements in the NESC or to discuss the situation with a knowledgeable plant engineer.

Lightning can have serious damaging effects on buried cable. While it would appear that aerial cable might be more severely damaged by lightning than buried cable, this is generally not the case. Substantial damage may occur under certain circumstances. When lightning strikes the ground, very high potential is created at the point where it strikes. This high potential tends to equalize itself over an area the size of which is determined by the resistance of the earth (earth resistivity). In areas of high earth resistivity, such as is found on the Piedmont plateau on which Atlanta, Georgia is located, the tendency of the lightning would be to find a conductor of some sort from which it could spread in rather long distances to equalize the charge created at its earth strike point. Good bonding and grounding techniques allow dissipation of such strikes with little or no damage to the CATV cable.

In areas of high earth resistivity and high frequencies of thunderstorms, currents carried by severe lightning flashes running as high as 200,000 amperes, will be common.

Taking all these factors into consideration, it is obvious that buried cable should be jacketed for protection against electrolysis and well grounded for protection against lightning strikes, particularly on long runs, and most particularly in areas of high resistivity and frequency of storms. Also, in rural areas where the earth resistivity is high or on long dead runs between communities it would seem desirable to consider the possible installation of lightning protective wires, which can be buried above the television cable and one or two feet apart. These wires need not be very large, in fact they could be #12 wires. The two wires act to provide a conducting plane which further protects the cable from lightning. Attempts should also be made in these areas to achieve uniformity of grounds throughout the system.

No discussion of bonding and grounding requirements would be complete without some mention of subscriber drops. In cases where distribution cable and drop cable outer conductors are electrically continuous the network ground is usually sufficient, although we are all aware that braided RG-59U cable, particularly over a period of time, offers little possibility of electrical continuity. Thus all subscriber drops should be grounded as close as possible to the home entrance by means of at least a #12 wire to a cold water pipe.

In summary, as we build large and more sophisticated CATV systems we must become aware that bonding and grounding requirements are at least as important as noise, hum and cross modulation specifications as the lack of necessary bonds and grounds could lead to the physical destruction of sections of our system, damage to subscriber's property or even to serious injury or death of an employee or a subscriber. System engineers, lets make a grounding test part of our proof of performance!!