NOTES

CLAMP-ON GROUND RESISTANCE MEASUREMENT (Models 3710 and 3730)

This measurement method is innovative and quite unique. It offers the ability to measure the resistance without disconnecting the ground. This type of measurement also offers the advantage of including the bonding to ground and the overall grounding connection resistances.

Principle of Operation

Usually, a common distribution line grounded system can be simulated as a simple basic circuit as shown in Figure 29 or an equivalent circuit, shown in Figure 30. If voltage E is applied to any measured grounding pole Rx through a special transformer, current I flows through the circuit, thereby establishing the following equation.

$$E/I = Rx + \frac{1}{\sum_{k=1}^{n} \frac{1}{Rk}} \qquad \textit{where, usually} \quad Rx >> \frac{1}{\sum_{k=1}^{n} \frac{1}{Rk}}$$

Therefore, E/I = Rx is established. If I is detected with E kept constant, measured grounding pole resistance can be obtained. Refer again to Figures 29 and 30. Current is fed to a special transformer via a power amplifier from a 1.7 kHz constant voltage oscillator. This current is detected by a detection CT. Only the 1.7 kHz signal frequency is amplified by a filter amplifier. This occurs before the A/D conversion and after synchronous rectification. It is then displayed on the LCD.

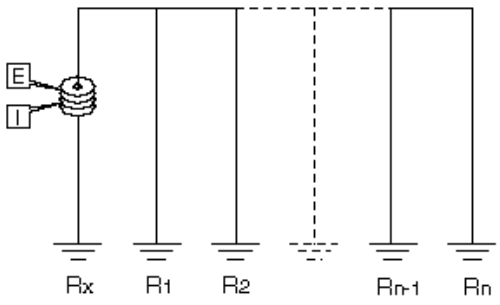

FIGURE 29

The filter amplifier is used to cut off both earth current at commercial frequency and high-frequency noise. Voltage is detected by coils wound around the injection CT which is then amplified, rectified, and compared by a level comparator. If the clamp is not closed properly, an "open jaw" annunciator appears on the LCD.

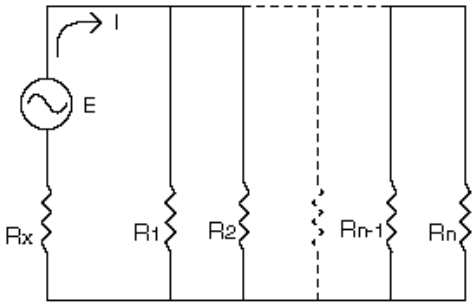

FIGURE 30

Examples: Typical In-Field Measurements

Pole Mounted Transformer

NOTES

Remove any molding covering the ground conductor, and provide sufficient room for the Model 3710/3730 jaws, which must be able to close easily around the conductor. The jaws can be placed around the ground rod itself. Note: The clamp must be placed so that the jaws are in an electrical path from the system neutral or ground wire to the ground rod or rods as the circuit provides.

Select the current range "A." Clamp onto the ground conductor and measure the ground current. The maximum current range is 30 A. If the ground current exceeds 5 A, ground resistance measurements are not possible. *Do not proceed further with the measurement*. **Instead, remove the clamp-on tester from the circuit, noting the location for maintenance, and continue to the next test location.**

After noting the ground current, select the ground resistance range "Ω" and measure the resistance directly. The reading you measure with the 3710/3730 indicates the resistance not just of the rod, but also of the connection to the system neutral and all bonding connections between the neutral and the rod.

Note that in Figure 31 there is both a butt plate and a ground rod. In this type of circuit, the instrument must be placed above the bond so that both grounds are included in the test. For future reference note the date, ohms reading, current reading and pole number Replace any molding you may have removed from the conductor. Note: A high reading indicates one or more of the following:

A) poor ground rod

B) open ground conductor

C) high resistance bonds on the rod or splices on the conductor; watch for buried split butts, clamps, and hammer-on connections.

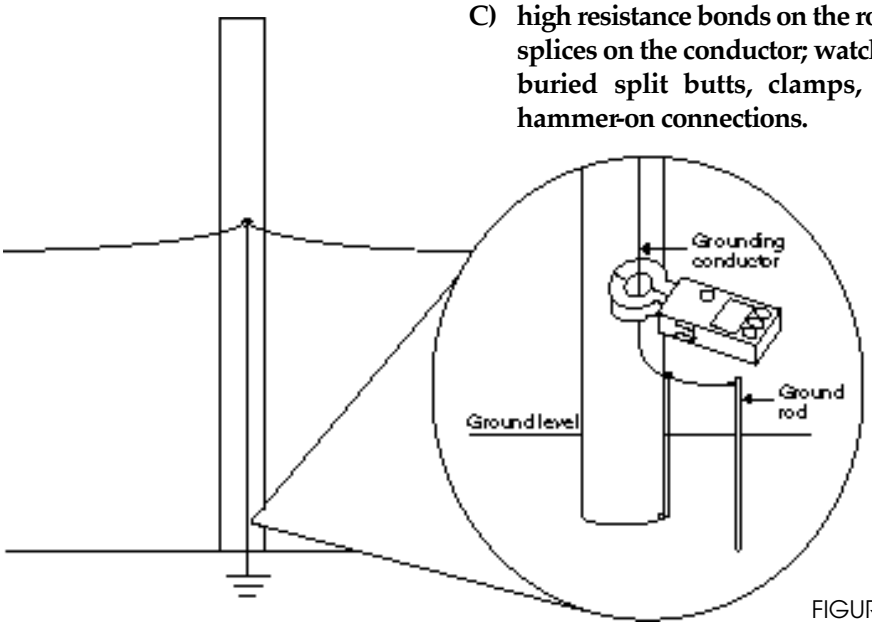

FIGURE 31

NOTES

Service Entrance or Meter

Follow basically the same procedure as in the first example. Notice that Figure 32 shows the possibility of multiple ground rods, and in Figure 33 the ground rods have been replaced with a water pipe ground. You may also have both types acting as a ground. In these cases, it is necessary to make the measurements between the service neutral and both grounded points.

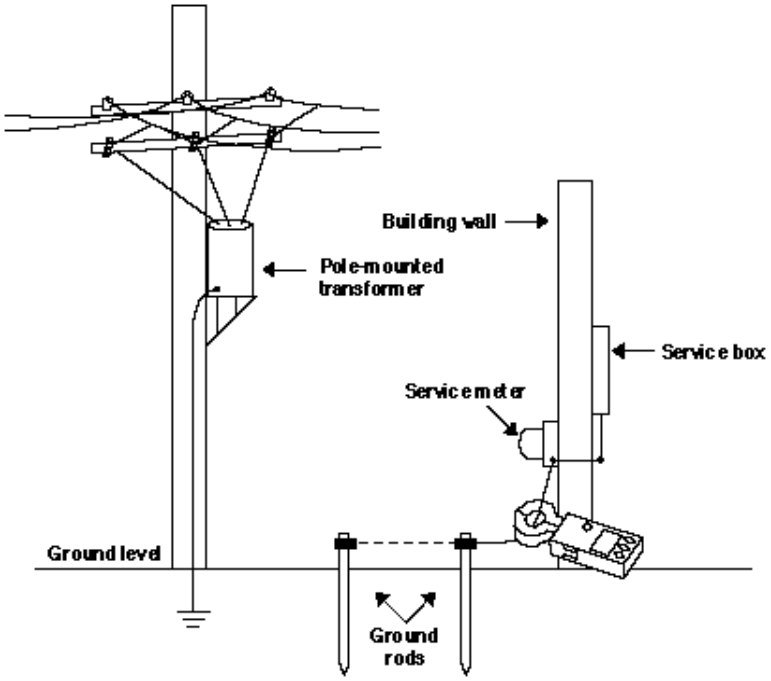

FIGURE 32

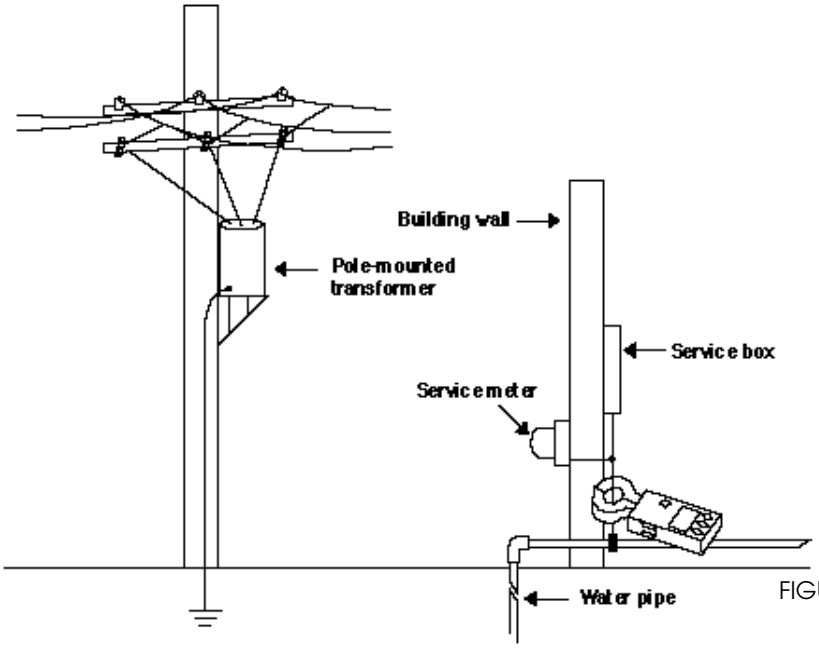

FIGURE 33

Pad Mounted Transformer

NOTES

Note: Never open transformer enclosures. They are the property of the electrical utility This test is for high voltage experts only

Observe all safety requirements, since dangerously high voltage is present. Locate and number all rods (usually only a single rod is present). If the ground rods are inside the enclosure, refer to Figure 34 and if they are outside the enclosure, refer to Figure 35. If a single rod is found within the enclosure, the measurement should be taken on the conductor just before the bond on the ground rod. Often, more than one ground conductor is tied to this clamp, looping back to the enclosure or neutral.

In many cases, the best reading can be obtained by clamping the 3710/3730 onto the ground rod itself, below the point when the ground conductors are attached to the rod, so that you are measuring the ground circuit. Care must be taken to find a conductor with only one return path to the neutral.

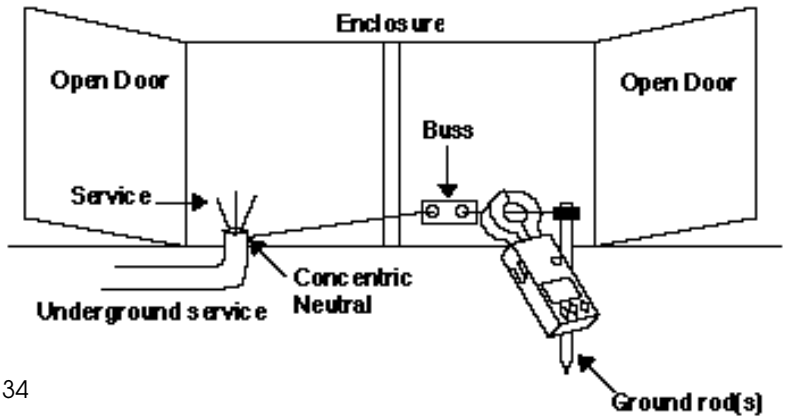

FIGURE 34

Transmission Towers

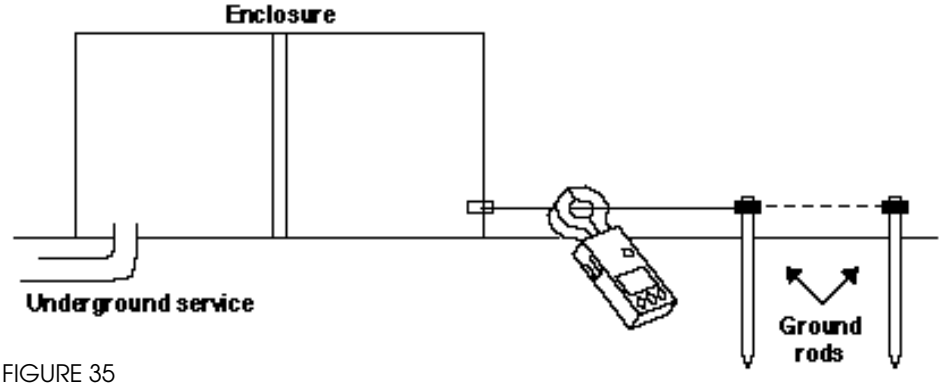

FIGURE 35

NOTES

Observe all safety requirements, since dangerously high voltage is present. Locate the ground conductor at the base of the tower. Note: Many different configurations exist. Care should be taken when searching for the ground conductor. Fig. 36 shows a single leg mounted on a concrete pad with an external ground conductor. The point at which you clamp the ground tester should be above all splices and connections which allow for multiple rods, butt wraps, or butt plates.

Central Office Locations

The main ground conductor from ground window or ground plane is often too large to clamp around. Due to the wiring practices within the central office, there are many locations at which you can look at the water pipe or counterpoise from within the building. An effective location is usually at the ground buss in the power room, or near the backup generator.

By measuring at several points and comparing the readings, both of current flow and resistance, you will be able to identify neutral loops, utility grounds and central office grounds. The test is efective and accurate because the ground window is connected to the utility ground at only one point, according to standard practices.

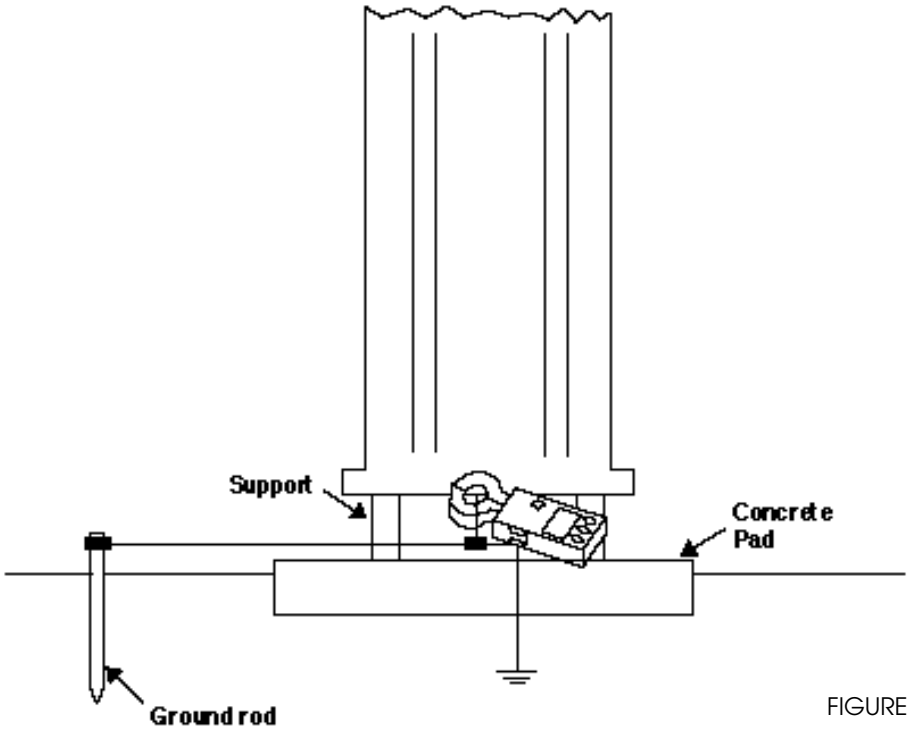

FIGURE 36

TELECOMMUNICATIONS

NOTES

The clamp-on ground tester developed by AEMC and discussed in the previous chapter has revolutionized the ability of power companies to measure their ground resistance values. This same proven instrument and technology can be applied to telephone industries to aid in detecting grounding and bonding problems. As equipment operates at lower voltages, the system's ability to remove any manmade or natural overpotentials becomes even more critical. The traditional fall-of-potential tester proved to be labor intensive and left a lot of interpretation to the person making the test. Even more important, the clamp-on ground test method allows the user to make this necessary reading without the risky business of removing the ground under test from service.

In many applications, the ground consists of bonding the two Utilities together to avoid any difference of potentials that could be dangerous to equipment and personnel alike. The clamp-on "Ohm meter" can be used to test these important bonds.

Here are some of the solutions and clamp-on procedures that have applications to the telephone industry.

Telephone Cabinets and Enclosures

Grounding plays a very important role in the maintainance of sensitive equipment in telephone cabinets and enclosures. In order to protect this equipment, a low resistance path must be maintained in order for any overvoltage potentials to conduct safely to earth. This resistance test is performed by clamping a ground tester Model 3710/3730 around the driven ground rod, below any common telephone and power company bond connections.

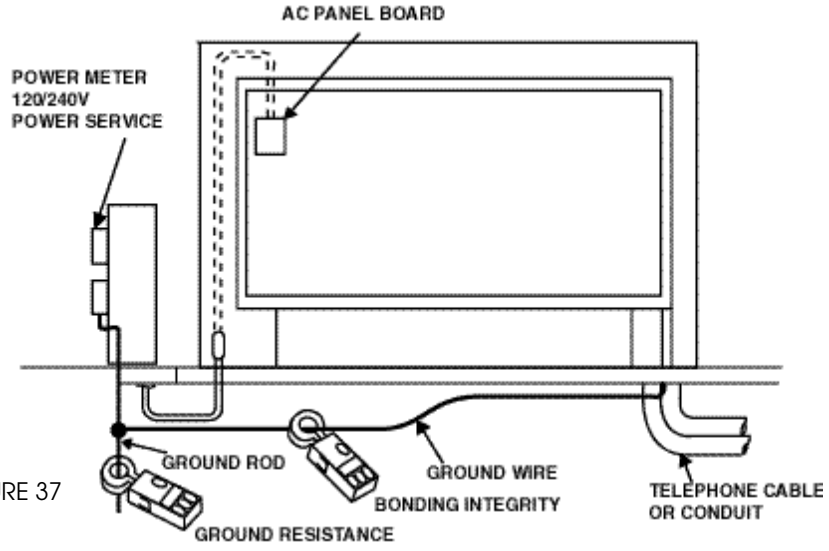

FIGURE 37

NOTES

To avoid any high voltage potentials between the telephone and power companies, a low resistance bond is established. Bonding integrity is performed by clamping around the No. 6 copper wire between the master ground bar (MGB) and the power company's multigrounded neutral (MGN). The resistance value displayed on the tester will also include loose or poorly landed terminations that may have degraded over time.

Additionally the clamp-on ground tester can be used as a True RMS ammeter.

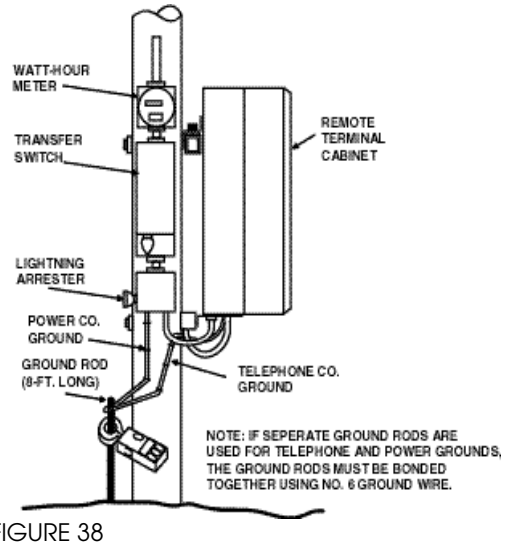

FIGURE 38

Pedestal grounds

All cable sheaths are bonded to a ground bar inside each pedestal. This ground bar is connected to earth by means of a driven ground rod. The ground rod resistance can be found by using the instrument clamped around the ground rod or the No. 6 cable connecting these two points. See figure 39.

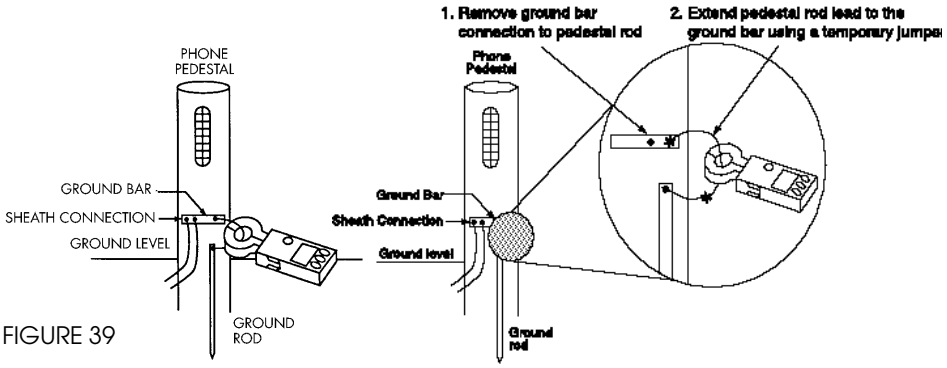

FIGURE 39

Note: temporary jumper required only if pedestal does not allow tester to fit.

Cable shield bonds to MGN

The cable shields in a buried or above ground telephone enclosure may be grounded by means of the power company's multigrounded neutral. The clamp-on ground tester can be utilized to ensure that this connection has been successfully terminated. The lowest resistance return path for the instrument to make this measurement will be from this bond wire under test to the MGN back through all other bonds up and/or down stream (theory of parallel resistance).

The clamp-on ground tester also is a True RMS ammeter.

NOTES

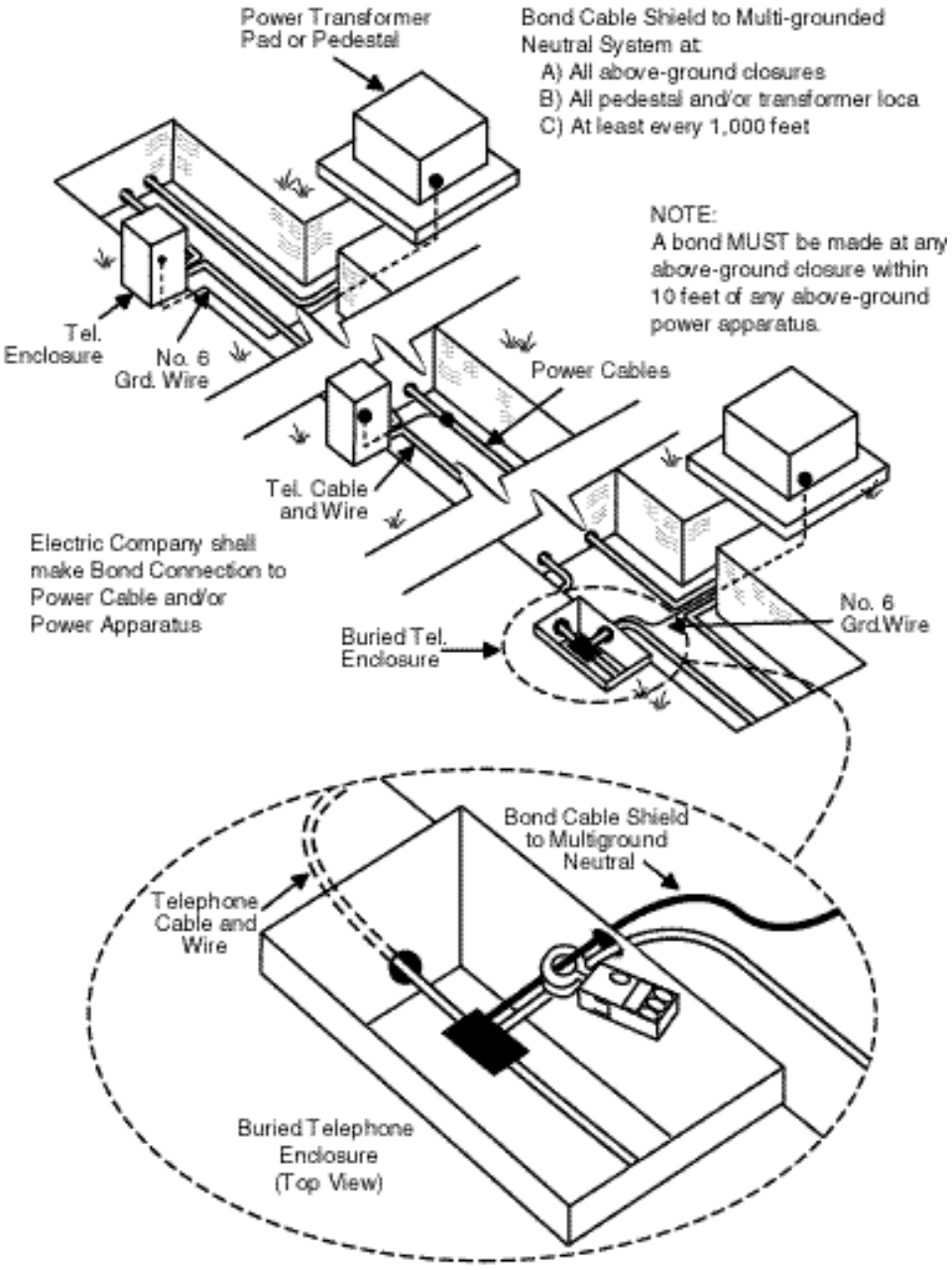

FIGURE 40 JOINT BURIED CONSTRUCTION – RANDOM SEPARATION

NOTES

Network Interface Device (NID) with a Protector Block

The typical customer connection is achieved with the tip and ring drop cable pair. In order to protect against an overvoltage situation on the telephone wires, a protector block is installed inside the NID. This protector has two internal devices that conduct only when unwanted overvoltages are present. In order for the protector to function properly, it must have a low resistance path for any fault to conduct to earth. This bonding and ground resistance potential can be verified by using the clamp-on ground resistance tester Simply take a short piece of wire and temporarily jumper the tip side (CO ground) to the ground connector on the protector block. By clamping around this jumper wire, you will now test the ground resistance potential including all terminations at this location. The return signal path required for the clamp-on ground tester to make this measurement will be the CO ground.

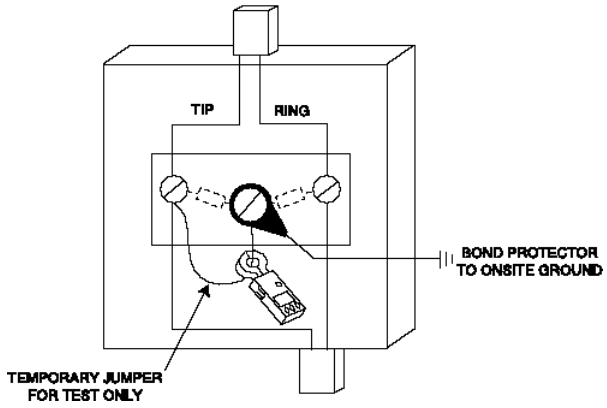

FIGURE 41

Overhead Telephone Distribution

Telephone systems delivered on overhead poles must also be bonded to the MGN. This is typically performed by supplying a No. 6 copper wire connected to the grounding strand above telephone space. If power is not supplied on these poles, driven ground rods must be installed at required pole intervals and subsequently tested.

<u>Note:</u> Coil wire for attachment to power company MGN

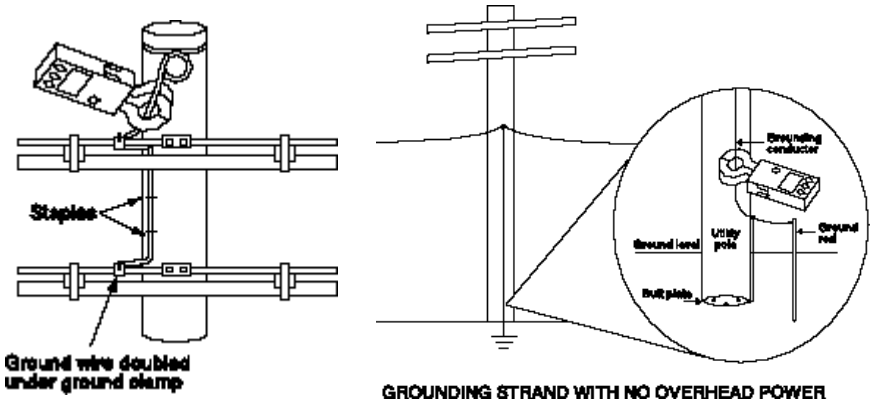

FIGURE 42