

LOCATING UNDERGROUND PIPES AND CABLES USING THE APC ELECTRONIC MARKER SYSTEM

Contents	Page
1. GENERAL	1
2. MARKER PLACEMENT AND BURIAL PROCEDURE	1
3. EMS MARKER LOCATION	1
4. CONDUCTIVE PATH TRACING	2
5. INDUCTIVE PATH TRACING	3
6. DEPTH DETERMINATION	4
7. CHECKING TEST SET OPERATION	4
8. TROUBLESHOOTING THE TEST SET	4

1. GENERAL

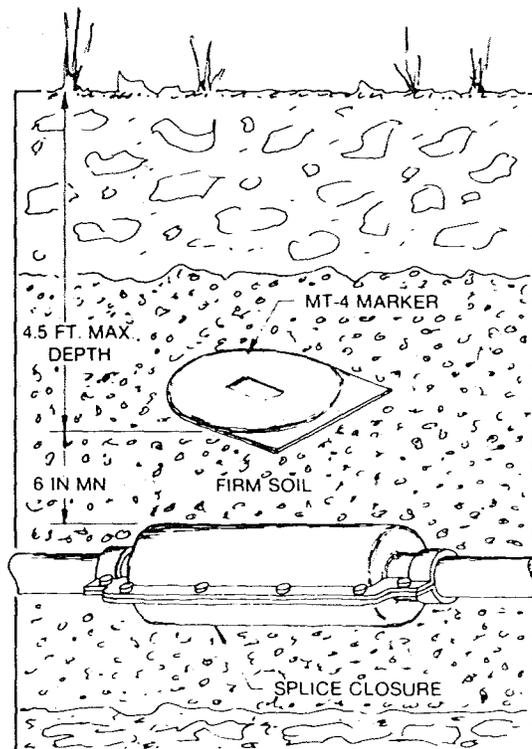
1.01 This section describes placing the passive EMS Marker at points that may need to be relocated at some future time. The section also describes the methods used for locating cable paths, underground metal objects or other buried conductors.

1.02 Section 106-350-901PT covers the description and maintenance of the APC EMS Test Set which consists of a portable detector and a separate portable transmitter. Section 106-350-901PT also covers the description of the EMS Marker.

2. MARKER PLACEMENT AND BURIAL PROCEDURE

2.01 The marker can be buried, as shown in Fig. 1, at any depth below grade down to 4-1/2 feet. The marker should be carefully placed over the installation to be marked (such as a branch splice, a load coil location, a splice location for future reinforcement or extension, a stubbed out conduit, a Feeder splice for SAI installation, or a drop wire storage.) Placing the marker on at least six inches of firm soil makes the marker serve as a digging shield when the location is reaccessed.

2.02 The marker should be at least six inches above any splice case and flat and level to insure maximum radiated signal from the EMS Marker to the EMS Detector.



Typical Marker Burial

Fig. 1

2.03 Cover the marker with about four inches of dirt before regular backfill work is done. Do not place the marker within six inches of any other metal or under any metal that could shield the marker's signal from the detector above ground.

3. EMS MARKER LOCATION

3.01 This mode of operation positively locates and identifies a buried APC Electronic Marker up to a depth of 4-1/2 feet. Only the detector portion of the test set is used for a marked location.

3.02 Turn the function switch to the Battery Test position. If the meter reading is marginal or bad, replace both 9-volt batteries.

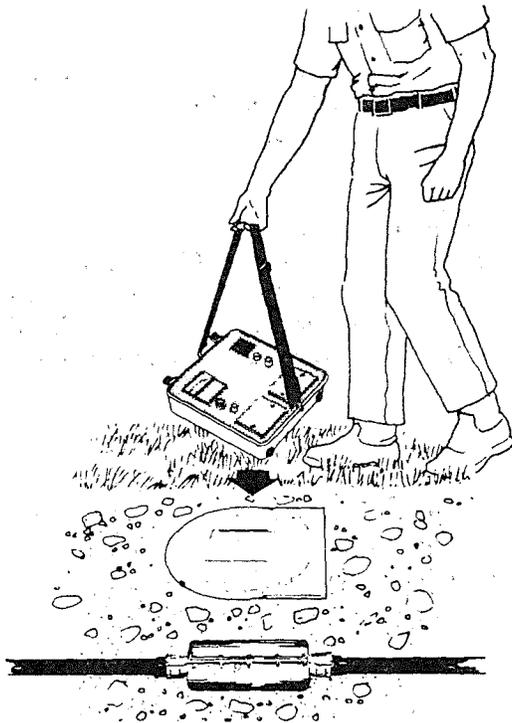
3.03 Turn the Function switch to the Marker position and turn the Sensitivity control to number 10 to provide the maximum detection range.

3.04 Check the detector operation by passing it over a known good EMS Marker, or if a marker is not available, pass the detector over the turned-off transmitter. In either case, a clear audible tone should be heard from the detector.

3.05 Attach the carrying strap to the two D rings on the detector and carry the unit in a horizontal position as shown in Fig. 2.

3.06 Search for the marker along the known cable path by walking in an "S" pattern while swinging the detector from side to side for maximum coverage. Using this pattern, it is possible to detect a marker at a distance of about five feet on either side of the path walked.

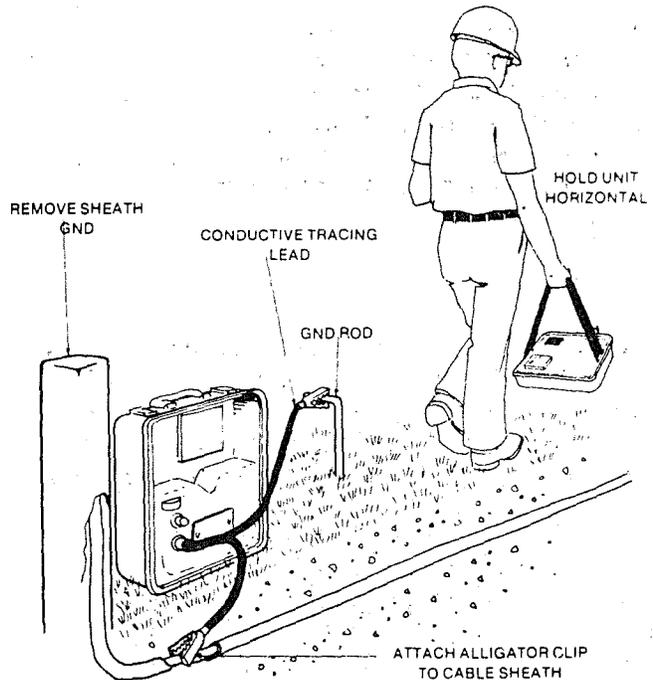
3.07 The presence of a marker is indicated audibly by an increase in tone and an up-scale deflection of the meter. Stop walking at this point and move the detector in all directions to determine the direction to the marker. Proceed toward the strongest signal, turn the Sensitivity control counter-clockwise as the signal increases. When the strongest signal is located, move the detector carefully in an "X" or crossing pattern to insure that the point of maximum signal has been found. The marker is buried directly under the point at which the strongest signal is obtained.



Locating the Marker
Fig. 2

4. CONDUCTIVE PATH TRACING

4.01 In conductive cable tracing the transmitter output is coupled directly to the sheath or a conductor in the cable to be traced. The transmitter is connected by means of the conductive cord provided, as illustrated in Fig. 3. If the cable sheath or conductor is grounded at the point of attachment of the transmitter, the ground should be removed if possible. If the ground isn't removed, the transmitter signal will go to ground and the cable trace is more difficult. For best tracing results, the cable sheath or conductor used should be grounded at the far end.



Conductive Cable Path Tracing
Fig. 3

4.02 Either end of the conductive cord may be connected to the conductor to be traced. The other end of the conductive cord should be connected to the ground rod. The ground should be placed as far as possible from the conductor and at a right angle from the conductor path. If the surface of the ground is hard or paved, a flat metal plate may be used instead of the ground rod.

4.03 Check the batteries in both the transmitter and the detector by turning the Function switch to the Battery Test position. The meter on each unit should read in the GOOD area. Replace batteries that are marginal or bad.

4.04 Turn the transmitter Function switch to Lo Power. This position is used for conductive path tracing as it provides an easily heard modulated signal. The Hi Power setting provides a stronger signal but is unmodulated.

4.05 The detector is used to trace the cable path. The detector is carried with the carrying strap attached to the two D rings on the test set. The detector may be used in either the null or the peak method of tracing.

4.06 Null Method: Place the mode switch on the detector in the Trace/Search position and adjust the Sensitivity control so that the meter indicates an on-scale reading of field strength from the signal on the conductor to be traced. A signal is heard on either side of the cable and no signal is heard when the detector is exactly over the center of the conductor. When walking the cable path using the null method, the detector should be moved from side to side over the cable path to be sure that you are walking along the center of the cable path. The width of the null can be varied by using the Sensitivity control. The more sensitivity used, the narrower the null will be.

4.07 Sometimes false nulls are received when the conductor path is associated with other cables running side by side. When such a situation exists, the induction from the conductor being tested sets up a field in the adjacent cables. Therefore, to more accurately follow the particular conductor in this situation, both the null method and the peak method should be used to be sure that you are over the right cable.

4.08 Peak Method: When tracing the cable path by the peak method, the detector should be carried on the handle as shown in Fig. 4. In this mode of operation, the signal is strongest when the detector is directly over the cable or conductor.

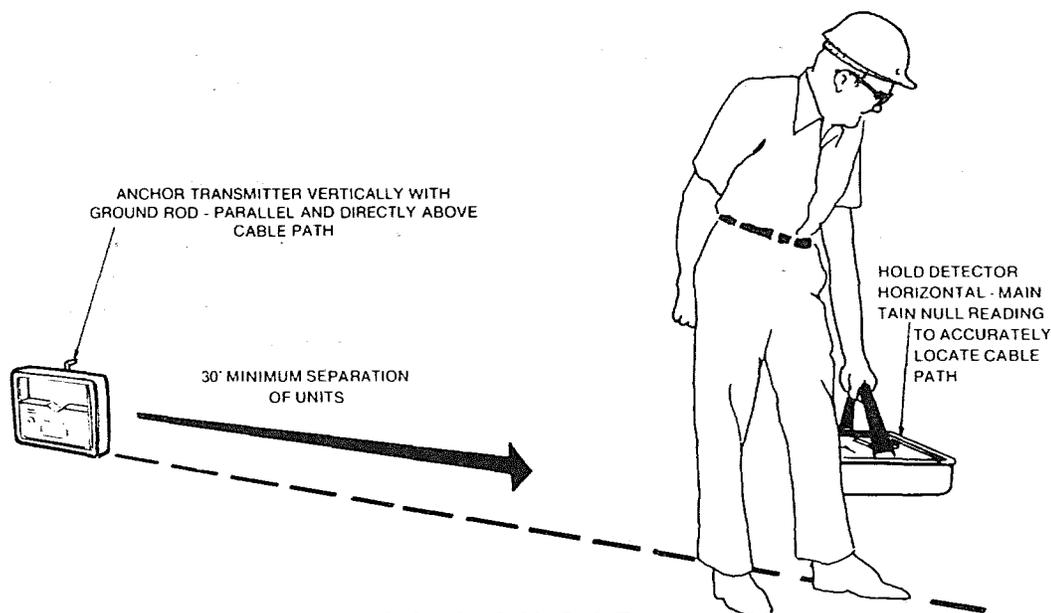
4.09 The cable path may be walked rapidly when using the peak method, for the operator will know when he is deviating from the cable or conductor path as the signal level drops. The peak method is not as accurate as the null method and should be used only when a general idea of cable location is necessary.

5. INDUCTIVE PATH TRACING

5.01 The inductive path tracing method is used when it is not possible to make a physical connection to the cable sheath or a conductor in the cable. Fig. 4 shows the manner of placing the transmitter for this method.

5.02 To achieve the best results with this method, both ends of the cable sheath or conductor should be grounded. The transmitter is held upright by using the ground stake pushed into the ground and inserted into the D ring on the top of the transmitter case. The conductive cord is not used in this method, and the transmitter should be placed in line with and directly over the cable.

5.03 Check the batteries on both units before operating. If the batteries are marginal or dead, they should be replaced.



Inductive Cable Path Tracing
Fig. 4

5.04 Turn the Function switch on the transmitter to either the HI or LO power position. The transmitter signal is inductively coupled to the cable to be traced.

5.05 In this mode, the detector cannot pick up the cable when it is within 30 feet of the transmitter. Within 30 feet, the detector receives a signal directly from the transmitter and not the cable being traced. The Detector Mode switch should be in the Trace/Search position.

6. DEPTH DETERMINATION

6.01 To determine cable depth, the exact path of the cable must be determined according to Parts 4 or 5 of this section.

6.02 After the center of the cable has been marked on the surface of the ground, hold the detector as close to the ground as possible at a 45 degree angle, parallel to the run of the cable. Move away from the cable, at a right angle to the cable path until a new null (using the null method) signal is obtained. This is illustrated in Fig. 5. The detector is at 45 degrees when the bubble is centered between the outer edge of the center ring and the black border of the level indicator.

6.03 Mark the position of the second null located away from the cable. The distance from the mark made above the center of the cable to the mark of the second null is the depth the cable is below the ground at the mark above the center of the cable. This can be checked by finding a third null on the other side of the cable run and checking with the first measurement.

7. CHECKING TEST SET OPERATION

7.01 Before making any tests, be sure the batteries in each unit are good by turning the Function switch to the Battery Test position. Replace marginal or bad batteries before making the following tests.

7.02 Detector Test for APC Marker: Prop a known good marker on a non-metallic chair or table so that it is in a vertical position. Hold the detector in a vertical position facing the marker. Turn the Function switch on the detector to the Marker position and turn the Sensitivity control fully clockwise. A strong audible signal should be heard and an off-scale meter reading should be seen. Move the detector away from the marker about 7 feet; the meter reading should drop to about 5. Rotate the detector through 90 degrees and note that the signal drops to a quiet level.

7.03 To test the path trace capability, set the transmitter on the floor in the vertical position and turn the Function switch to the Lo Power position. Then walk away with the detector to a distance of about 20 feet. Turn the detector Function switch to the Trace/Search position and the Sensitivity control fully clockwise. A pulsating tone should be heard in the detector speaker when the detector is in a plane parallel with the transmitter. Rotating the detector 90 degrees to the transmitter should produce a null or a no signal. Switch the Function switch on the transmitter to the Hi Power position. The same tone should be heard at 20 feet, except that it will be a steady tone instead of a pulsating tone. Again, that tone should drop off when the detector is rotated 90 degrees with respect to the transmitter. Plug the conductive trace cord, with the free ends open, into the conductive trace jack on the transmitter while tone is present at the detector. The tone should stop. Connect the free ends of the conductive trace cord together. The tone should be heard again at the detector.

7.04 If the set fails to meet the above tests, it should be returned to the factory for servicing.

8. TROUBLESHOOTING THE TEST SET

8.01 Table A provides a list of symptoms, causes and remedies and should be referred to whenever the test set meets the tests describes in Part 7, but does not appear to be working properly.

TABLE A

SYMPTOMS	CAUSE	REMEDY
<p>Path Tracing Problems</p> <p>1. Tracing signal is weak from the detector.</p> <p>2. Too much signal in area preventing cable location.</p>	<p>Detector sensitivity is not high enough</p> <p>Improper connection of transmitter to cable.</p> <p>Attempting to trace wrong cable.</p> <p>Detector too close to transmitter.</p> <p>Cable not grounded at far end.</p>	<p>Turn the Sensitivity switch clockwise to increase sensitivity. Be sure that the Function switch is set on the Trace/Search position. If the set still seems insensitive, test the detector thoroughly as described in Part 7.</p> <p>Check to be sure that the transmitter Function switch is on the Hi Power setting. Check the connection of cords and clips from the conductive trace jack to the cable being traced. Make sure that the earth-ground at the point of attachment of the transmitter is removed, and check that there is an earth-ground at the far end of the cable being traced. If tracing is being attempted in the inductive mode, then both ends of the cable should be grounded to earth.</p> <p>Check to make sure that the cable on which the transmitter is attached is the same one that is being traced.</p> <p>Move the transmitter and the detector at least 30' apart.</p> <p>Use the Lo Power setting instead of Hi Power.</p> <p>Ground the cable at the far end.</p>
<p>Battery Problems</p> <p>1. No meter indication with Function switch set at Battery Test position.</p> <p>2. Abnormally short battery life.</p>	<p>Battery is not properly connected.</p> <p>Cold weather or batteries have been stored too long.</p>	<p>Be sure that the two snap-in clips on the batteries are properly connected.</p> <p>All test sets exhibit shortened battery life using dry-type batteries at low temperatures. If this problem becomes severe, then the test set should be kept in a room temperature environment as much as possible. If batteries are stored for many months on the shelf, they may lose some of their initial charge and will not give proper battery life. If this occurs, try to obtain fresh batteries.</p>

TABLE A (Contd)

SYMPTOMS	CAUSE	REMEDY
<p>Marker Location Problems</p> <p>1. No meter indication when believed to be near an APC Marker with the Function switch set at the Marker position and the Sensitivity knob set at 10.</p> <p>2. Meter indicates a marker nearby but no distinct location can be found where the signal peaks sharply.</p> <p>3. Two signals are received with a very sharp null in the center.</p> <p>4. Detector indicates a marker with no known marker near.</p> <p>5. Detector indicates continuously when not near a marker.</p>	<p>No working marker present.</p> <p>Marker buried too deep.</p> <p>More than one marker buried in close proximity.</p> <p>Marker buried in vertical position.</p> <p>Unexpected marker is buried nearby, especially likely if near a cable path.</p> <p>Detector is picking up a signal from the transmitter whether it is on or off.</p> <p>High voltage power lines or some noise source.</p>	<p>Check detector with an unburied marker known to be good. See general equipment tests, Part 7.</p> <p>Work with the detector close to the ground and try to get a signal indication. Maximum recommended separation between marker and test set is 6 feet. Marker buried at a depth greater than 6 feet is not detectable.</p> <p>Hold the detector close to the ground and try to isolate the two or more maximum signals.</p> <p>The marker is easily located except that the null mode should be used for location rather than the peak mode, or hold the detector in a vertical position by the handle and look for maximum signal.</p> <p>Move the detector to another location to see if the signal decreases.</p> <p>Turn the transmitter off and move it at least 10 feet from the detector.</p> <p>This type of noise will normally cause a garbled signal from the detector. If this is encountered, turn the sensitivity control down until this noise is not bothersome.</p>