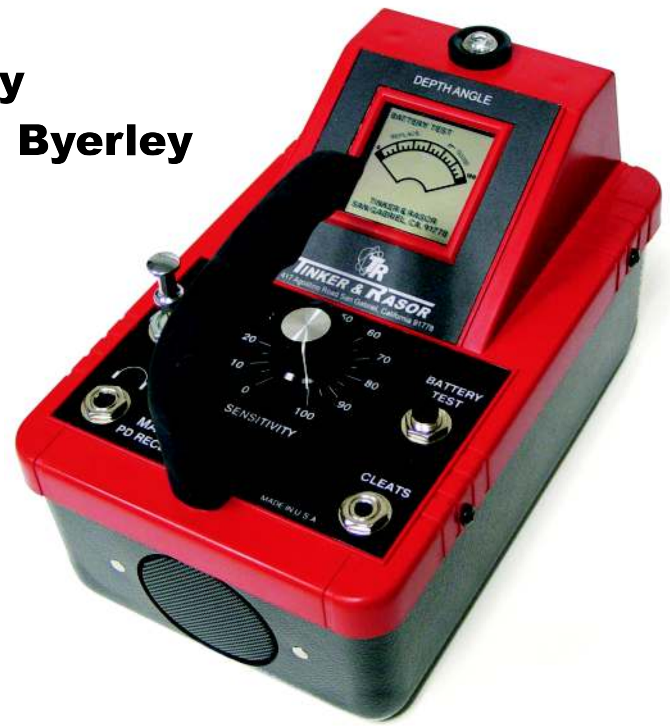
ELECTRICAL SURVEY METHODS OF UNDERGROUND COATED PIPELINES

(Locating and Identifying Holidays and Cable Breaks)

By
Darrel D. Byerley



Tinker & Rasor
P.O. Box 281
San Gabriel, CA 91778 USA

www.tinker-rasor.com
Info@tinker-rasor.com

ELECTRICAL SURVEY METHODS OF UNDERGROUND COATED PIPELINES

Improved methods of locating coating faults, insulating joints, foreign line contacts and pipe locations are to be discussed. The improved method involves the use of relatively large flow of stable AC audio frequency current through the pipeline and a surface traverse with inductor and amplifier to locate the desired point or item by using the "NULL" method.

LOCATING COATING FAULTS ON AN UNDERGROUND PIPELINE

This type of survey is commonly referred to as Pearson survey, based on the original method of Mr. J. M. Pearson (1). The original concept of his operating techniques are still in use today and this article is designed to inform the industry of improvements both in methods and equipment.

The original technique was to apply from 5 to 10 milliamperes of AC current at approximately 1,000 c.p.s. between a coated pipeline and an earth ground. The AC energy is passed from the pipe metal to the soil through the faults in the coating. The location of the "electrical leaks" can be detected with suitable indicating apparatus and marked for excavation. The measurement of such electrical leaks is conducted across short spans of earth directly above the coated pipeline. Under good conditions, two thousand feet of pipeline coatings can be tested in either direction from the input AC power source.

Relatively small amounts of AC energy have heretofore been available to apply to a coated pipeline system. The operational distances of a survey of this type that can be performed away from the AC energy source is rather limited, plus the fact that the survey must be conducted directly over the coated pipeline. When a relatively small amount of AC audio energy is used, the signal receiving instrument must be of high gain. Although the high gain receiver has merit with relationship to distances away from the AC input source, it becomes increasingly susceptible to unwanted signals and cleat noise.

One of the greatest drawbacks in the use of relatively small amounts of AC audio energy in an unfiltered high gain receiver has been to observe a rather broad difference in the amounts of current flowing to the earth via coating faults. This broad difference in signal can well mean the unnecessary excavation of larger areas than needed to make repairs to the coating.

IMPROVED EQUIPMENT

The oscillator desirable for the improved method should be capable of developing 5 to 10 watts of stable AC audio frequency energy. It should be equipped with output voltage taps to obtain proper impedance match to the coated piping system and a signal interrupter so that the audio signal can be distinguished from unwanted signals. To obtain maximum current flow on a coated piping system, the placement of the grounding system is of the utmost importance. The ground system of the oscillator should be made to the best ground available at a given location, preferably grounded to another underground system which is foreign to the one under surveillance. After proper grounding of oscillator is assured, the driving voltage switch on the oscillator should be advanced so as to give proper impedance match to the coated piping system. For best results, it is highly advantageous to have a receiver with a low input impedance such as a transistor type. The low impedance input material decreases cleat contact noise and also make it unnecessary to use shielded cable between the two ground reference points. The audio amplifier should be equipped with filters that are resonate to the frequency of the oscillator. This resonate filtering will eliminate most of the unwanted signals.

IMPROVED METHODS

There are two ways AC audio frequency energy can return to the earth ground system of the audio oscillator when audio current is caused to flow in a coated pipeline. One way is through the good portion of the high electrical resistant coating by electrical capacity to the earth and the other path of return is through coating faults where the metal pipe is making good contact with the earth. To what percentage the audio current divides, is dependent entirely upon the electrical resistance of the coating, and resistance of the soil adjacent to the coating fault. Most coatings are of relatively high electrical resistant material and the voltage potential that is present at a coating fault can be intercepted and pin-pointed. To measure the difference in potential of the applied AC audio current between the coated piping system and the earth ground, it is necessary to have two mobile ground reference points. The ground reference points usually consist of two men, both of whom wear electrical conductive type shoe cleats, which in turn are connected electrically to the audio receiver, borne by one of the operators. The electrical connection between the two ground reference points is made by means of an insulated single conductor wire approximately 25 feet in length. This 25 foot separation of the ground reference points should be maintained during the original traverse over the coated piping system to assure detection of all signal responses due to the potential differences between the piping system and the soil. The signal response observed by the operator will vary considerably due only to changes in soil resistance that are usually present during a survey of this type. Soil resistance vary greatly, making the "NULL METHOD" of operation invaluable. The "NULL METHOD" eliminates unnecessary investigations due to changes in signal level.

LOCATING ISOLATED HOLE AND INVESTIGATION

When audio current is applied between a coated pipe and a good earth ground, the NULL can be obtained at any single coating fault. It is of the utmost importance that the ground reference points continue their traverse through the complete NULL. After the complete NULL effect of the signal is observed by the operator, the two ground reference points should be shortened to approximately 5 feet, and a slow reverse traverse be made over the point of NULL indication. By shortening the distance between the two reference points, the point of NULL can be pin-pointed and the coating fault is assumed to lie at this point. The complete investigation of each point of indication can be conducted in the following manner. Place one ground reference contact at the point of NULL indication and with the other ground reference contact, make a 360 traverse, the audio tone level remains nearly constant, it can be assumed that the original indication was created by a coating fault. However, if, during the 360 traverse , there is a point where a substantial change in the audio tone level is noted, it can be assumed a foreign system is lying at right angles, and in close proximity to the coated pipeline under surveillance. An indication of this type may not warrant the excavation but would not necessarily rule out the possibility of a coating fault at this point.

INSPECTION OF POOR COATING

The original traverse is conducted in the pre-described manner, that is, with two ground reference points spaced at 20-25 feet over the pipeline. When the first ground reference contact approaches the area of poor coating, there will be a sharp rise in the audio tone level. Where the area of poor coatings begins and is directly between the two ground reference points, the audio tone will drop below normal background level and will remain at this level until the second ground reference contact arrives at a point of good coating. At this point, the audio tone will rise sharply and, as the two ground reference points proceed, the audio tone will taper off to normal background level. It can then be assumed that the area , where the audio signal is below normal background level, is in generally poor condition.

INVESTIGATION

There are two testing procedures that can be carried out in a minimum of time to determine whether the poor coating indication consists of a continuous discontinuity or a series of coating faults. Again, place the first ground reference point over the pipeline at any point between the broad NULL. The second ground reference point makes a 360 traverse around the stationary contact point. If the audio tone drops sharply as the traverse is made directly over the pipeline in each direction of the stationary ground reference point, it can be assumed that the coating is in generally poor condition. To distinguish between a continuous discontinuity of a series of coating faults, place one ground reference contact directly over the pipeline and the second ground reference contact at a 20 to 25 foot right angle to the pipeline. A continuous coating discontinuity produces an almost symmertrical circular field of potential gradient so the audio tone would rise slightly above normal background level and remain constant throughout the area of indication. In the case of numerous coating faults, all of the potential gradients appear on the ground's surface at right angles to the pipeline. These potential differences can be recognized by the sharp increase in audio signal strength at the larger coating faults and marked for excavation.

LOCATING COATING FAULTS BY ELECTRICAL CAPACITANCE

The latest innovation of locating coating faults on underground pipelines is by electrical capacitance. The survey is conducted with substantially the same equipment, enabling the operator to locate coating faults under adverse soil conditions and paved areas, The method eliminates the direct electrical ground contacts (shoe cleats). The reference points consist of two men whose bodies are electrically connected to the audio receiver. This electrical connection causes a capacitance effect of each operator between the audio receiver and the pipeline. the method of operation using the capacitance technique is conducted in he same manner as when using ground contact (shoe cleats). However, the capacitance method should only be used when it is impractical to make good electrical contact with the soil.

PRELIMINARY PROCEDURES

Prior to the actual electrical survey, there are several steps to follow:

1. The locating and marking of the pipeline. (When using relatively large amounts (5-10 watts) of AC audio frequency energy, it is not necessary to conduct the survey directly over the pipeline, but it should be conducted within 10-15 feet either side).

2. Pipeline should be insulated at the point from which the survey is to start and well grounded at the opposite end.

3. All rectifier connections and bonding to foreign systems should be removed.

A survey of this type should be conducted only when soil compaction around the pipe is assured and moisture content is present in the surface soil. This type of inspection is most effective on well coated pipelines when there are very few electrical connections to the surrounding earth. The ideal time for this type survey would be on newly constructed coated piping systems after soil compaction is assured. When conducting this type survey on older coated piping systems, it is often found that areas which were once anodic have become inactive and energy will not flow to the soil at these areas. Consequently, when active anodic areas are located and repaired, it is often found the inactive anodic area becomes active and another survey would be necessary. This would indicate a number of electrical surveys would be necessary to assure the pipeline coating holiday free.

OPERATING DISTANCES

Under ideal conditions, using 5-10 watts of stable AC audio current with proper impedance match to the coated pipeline, and suitable low impedance, resonate filtered audio receiver, surveys have been conducted on seven miles of coated pipe without advancing the AC input power source. On a 10 year old coated pipe, distances of approximately 2 miles have been inspected without advancing the AC input oscillator. This line has mastic type coating.

1 J. M. Pearson, Petroleum Engineer, 12 (10) 82 (1941).