PROCEDURES
PIPE TO SOIL READINGS

5.0 PURPOSE

The purpose of this section is to establish the appropriate procedure associated with taking pipe to soil potential readings.

5.1 SCOPE

This section covers the following:

A. Appropriate pipe to soil readings.

B. Testing copper-copper sulfite Half Cell.

C. Appropriate method of taking pipe to soil readings.

D. Remedial action.

E. IR Drop / Millivolt Shift.

5.2 PIPE TO SOIL READING

A. Pipe-to-Soils readings shall be taken anytime that buried or submerged pipe coating is exposed:
   1. Coating is removed or damaged.
   2. Not required when vacuum excavated.

B. Adequate Cathodic Protection:
   1. The level of cathodic protection shall be considered adequate when the minimum pipe to soil potential is at least a **-0.85 volts (Negative 850 millivolts)** for metallic pipelines. This is the level at which metallic pipe no longer corrodes.
   2. A 100 milivolt shift is accomplished after the CP has been turned off (may require 2minutes to 24 hours)

C. Inadequate Cathodic Protection:
   1. Reading less than – 0.85 volts (more positive than) may indicate inadequate CP requiring medial action to correct the situation

D. Excessive Cathodic Protection:
   1. The amount of cathodic protection must be controlled so as not to damage the

protective coating or the pipe. This is accomplished by limiting the maximum "on" pipe-to soil potential to **negative (-) 2.5 volts.**

2. Any reading greater than - 2.5 volts, indicates excessive CP requiring remedial action to correct the situation.

E. CP records shall be maintained for no less than 5 years. It is recommended that these CP records be maintained for the life of the pipeline.

5.3 TESTING HALF CELLS

Prior to taking any pipe to soils readings it is important to check or calibrate the reference electrodes being used. This can be undertaken as shown in Fig 1. The test is simply to place the porous plugs of a standard (unused) electrode and the field electrodes end to end and measure the millivolt difference. Generally, if the difference is less than 4 to 6 millivolts, no maintenance of the electrodes will be required.

Testing of the field reference electrodes should be undertaken each morning prior to the start of the survey. The millivolt difference and polarity between the working electrodes and the standard should be recorded.

TESTING REFERENCE ELECTRODES
PRIOR TO FIELD USE

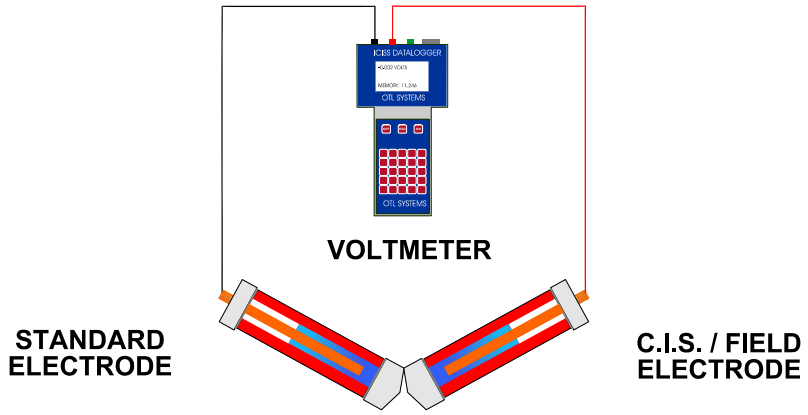

Fig 1

Note: The special calibrated reference electrode or standard reference electrode is <u>not</u> to be used in the field, except for the above test. Any Half-cell testing deficient shall be repaired or replaced.

5.4 PIPE TO SOIL PROCEDURE (STRUCTURE TO SOIL POTENTIAL)

A. Pipe to soil readings are taken utilizing a copper- copper sulfate half-cell and a voltmeter.

B. To ensure a proper pipe to soil potential reading, remove the cap and place the porous plug of the copper/copper sulfate reference electrode in firm contact with earth over the pipeline or close to it.

C. This may require "digging in" where the earth's surface is dry. In dry areas, it is necessary to moisten the earth around the electrode with fresh water to obtain good contact.

D. The red lead/wire from the digital voltage meter is connected to the structure/pipeline (via test point terminals or direct contact with pipeline); the black lead from the digital voltage meter is connected to the half cell; and the pipe to soil potential is read and recorded.

E. Some Half-cells utilize the volt meter attached directly to the top if the half-cell and require only on lead to be attached to the pipeline facilities or test lead to be tested.

F. The voltmeter must be of high input impedance to ensure accuracy.

PROCEDURES
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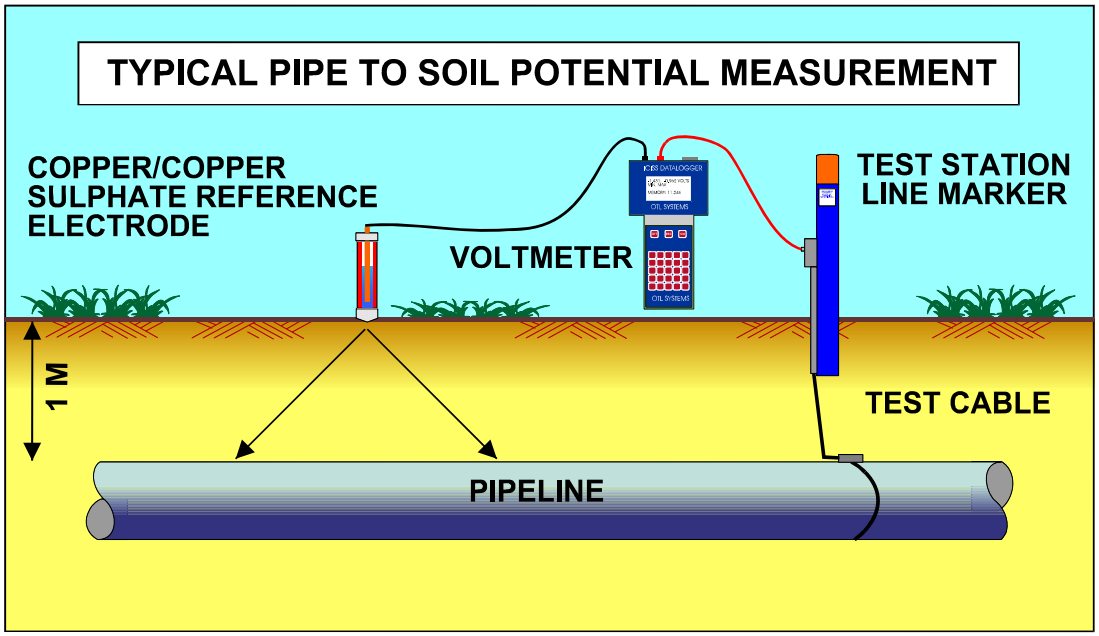

Fig 2

Shows the typical arrangement at a test station when a pipe to soil potential is being measured.

The positive terminal of the voltmeter is connected, by a test lead (red), to the pipeline through the test cable in the test station. The negative (black) lead is connected to the half cell. The pipe to soil potential will be displayed on the meter. The magnitude of this potential will depend on the Cathodic Protection system status, but may be in the range of -1000 mV to -1500 mV.

This potential represents the average potential of the pipeline at this location.

5.6 REMEDIAL ACTION

A cathodic voltage of a minimum of (-) 0.85 volts for steel pipelines with reference to a saturated copper-copper sulfate half-cell is the desired reading indicating an adequate level of cathodic protection.

A. If an area does not meet the above criteria, either a null survey using an appropriate

faultfinder or Current Mapper or P/S survey shall be conducted to locate the shorted area within 90 working days after determination that the area does not meet the above criteria.

B. The repair of the area shall be started within 90 working days of the discovery of shorted services or underground contacts.

C. The same shall apply to long service areas where current is supplied by an anode or anode bank. Isolated short services or valves shall be repaired within 90 working days after discovery of noncompliance with the above criteria.

D. If a part has to be ordered, repairs shall be completed within 90 working days of receipt of repair materials or parts.

1. The voltmeter has 2 test leads. The red lead is positive and the black lead is common. The red lead is attached to the pipe or test lead, and the black lead is attached to the copper sulfate half cell (corrosion cell) for the purpose of taking CP readings. The voltmeter must be set to read Direct Current Volts.

2. Other uses include a meter designed for and attached directly to the half cell with one lead. This lead is attachment to the pipe or test lead for the purpose of taking CP readings.

5.7 IR DROP

A. IR DROP / IR ERROR

1. IR drop is a product of current and resistance. (Voltage drop) Voltage drop is negligible in the measuring circuit under the following conditions:
   - Metallic path lengths are short.
   - Good contact between reference cell and electrolyte (moist soil).
   - Good connection points (clean metal to metal contact).
   - High-input impedance meter is used.
   - Resistivity is low.
2. All the voltage drops in the measuring circuit are controllable except for the drop across the electrolyte (surrounding soil or other medium). To reduce the IR drop:
   - Place the electrode near the structure coating holiday.

- Or, interrupt the current flow.
- Calculations can also be made to subtract the IR drop.

3 When current is interrupted, the potential should be measured at "instant off" which refers to the potential after IR drop is eliminated but before polarization begins to dissipate.

5.8 MILLIVOLT SHIFT

A. 100 Millivolt Shift

1. The criterion is based on the difference between the two potentials, corrosion potential and polarized potential. (100 mV shift)
   - Momentarily interrupt the current flow to read the polarization potential.
   - With the current remaining off, the polarization will dissipate, and polarization is the measurement of interest.
   - When no further drop is recorded this is the depolarized potential.
   - If this is greater than 100mV difference, the pipe is protected regardless of the half cell reading.
   - The same is true in measuring the polarized potential after the current is reestablished and no further rise is recorded.