State of the Art Cathodic Protection Practices and Equipment
State of the Art

Definition:

The level of development (as of a device, procedure, process, technique, or science) reached at any particular time usually as a result of modern methods
Cathodic Protection

✓ Type

✓ Materials

✓ Installation

✓ Monitor / Survey Techniques
Types of Cathodic Protection

Sacrificial Anode

- Small Current Requirement
  - Well Coated Structures
  - Isolated Structures

- Low to Medium Soil Resistivity
Types of Cathodic Protection

Impressed Current

- Large Current Requirement
  - Poorly Coated Structures
  - Shorted Structures

- High Soil Resistivity
Sacrificial Anodes
Magnesium & Zinc Typical
Sacrificial Anode
Zinc Ribbon
TYPICAL SACRIFICIAL ANODE INSTALLATION

SINGLE ANODE

- PIPE
- ANODE
- GRADE
- AT PIPE DEPTH TO 5' TYPICAL
- 5' MIN

MULTIPLE ANODE

- PIPE
- ANODE
- ANODE
- ANODE
- ANODE
- GRADE
- 10'-15' MIN FOR MAGNESIUM
- 5' MIN FOR ZINC
- 5' TO 15' TYPICAL
Typical Sacrificial Anode Installation
Typical Sacrificial Anode Installation
Typical Sacrificial Anode Installation

*Ribbon Anode*
Impressed Current Rectifier

- Constant Voltage
- Constant Current
- Auto Potential
- Pulse

- Alternative Power
  - Solar
  - Thermo Electric
  - Wind
  - Hydro
Impressed Current Anode

Graphite
Impressed Current Anode

High Silicon Cast Iron
Impressed Current Anode
Mixed Metal Oxide
TYPICAL IMPRESSED CURRENT ANODE INSTALLATION
DISTRIBUTED
TYPICAL IMPRESSED CURRENT ANODE INSTALLATION
REMOTE

- RECTIFIER
- PIPE
- 200' TO 500' TYPICAL
- ANODES
TYPICAL IMPRESSED CURRENT ANODE INSTALLATION DEEP

PIPE

50' TO 400' TYPICAL

ANODE WITHIN SLURRIED BACKFILL
TO ANODE JUNCTION BOX
MINIMUM 2'-0" BURIAL

SURFACE CASING TO 40 FT

VENT PIPE

SAND / BENTONITE MIXTURE

ANODE LEAD WIRES / HALAR

ANODES 10 EACH
ON 10 FT CENTERS

LOW RESISTANCE BACK-FILL
BOTTOM FILLED
SLURRIED
Impressed Current Anode Installation

*Distributed or Remote*
Impressed Current Anode Installation

Deep
Storage Tank Bottom CP

New

Existing
Vacuum Excavation

- Utility Locating
- Anode Installation
- Reference Cell Installation
- Test Station Installation
- Depth of Cover Survey
- Expose Pipeline for Coating Inspection
- Subsurface Utility Engineering
Vacuum Excavation

Utility Locate
Vacuum Excavation

Anode / Test Station Installation
Cathodic Protection Testing

- Equipment
- Tools
- Materials
- Survey Methods
C.P. TEST EQUIPMENT

HIGH INPUT IMPEDANCE DIGITAL VOLT METER
• 10 MΩ OR GREATER

COPPER/COPPER SULFATE REFERENCE CELL
• CLEAN, FULLY CHARGED & CALIBRATED

TEST WIRES WITH ALLIGATOR CLIPS
• SELECTION OF SHORT & LONG WITH NO SPLICES

CLEAN WATER
• TO SATURATE THE TEST LOCATION

MISC. HAND TOOLS
• TO MAKE MINOR REPAIRS ON-SITE
Data Collection

Read Only

Self Storage
Reference Cell / Electrode

• Contaminated every time it gets used
  ✓ Clean Regularly
  ✓ Check Regularly

• The “Weakest Link” in Cathodic Protection Testing
Cathodic Protection Criteria

*NACE SP0169*

1. -850 mV with IR Drop Considered

2. -850 mV Polarized

3. 100 mV Polarization
CP Test Location / Test Station
1. Connect (+) lead of volt meter to structure terminal
2. Connect (-) lead of volt meter to reference cell terminal
3. Read & record measured potential
Permanent Reference Electrode
1. CONNECT (+) LEAD OF VOLT METER TO STRUCTURE TERMINAL
2. CONNECT (-) LEAD OF VOLT METER TO REFERENCE CELL TERMINAL
3. PLACE REFERENCE CELL DIRECTLY OVER OR ADJACENT TO PIPE
4. READ & RECORD MEASURED POTENTIAL
PROPER REFERENCE CELL PLACEMENT

PIPE

GRADE

100' (TYPICAL)

ANODE

850V

ANODE

PIECE
Coupon Test Station

- IR Free Potential Reads

- No Need to Interrupt:
  - Rectifiers
  - Sacrificial Anodes
  - Foreign Bonds

- Calculate Metal Loss
Remote Monitoring

- GPS Controlled
- Automatic Pipe-to-Soil Potential Reads
- Automatic Rectifier Voltage & Amperage Reads
- Alarm Notification
- Interruption Capabilities
- Cellular, Satellite & Radio Communication
Circuit Interruption

- Rectifiers & Foreign Bonds
- Sacrificial Anodes
- GPS Controlled
- Programmable Schedule
Fault Protection & Grounding

- Solid State
- Induced AC Voltage Mitigation
- Stray DC Voltage Blocking
- Insulated Joint Protection
Ultrasonic Thickness \((UT)\) Gauges
Thermite Welding
Over-the-Line Survey Techniques
Over-the-Line Survey Techniques

- Close Interval Survey (CIS)
  - *Cathodic Protection Potential Profile*

- Pipeline Current Mapping (PCM)
  - *Maps Cathodic Protection Current Loss due to Coating Failure or Shorted conditions*

- Direct Current Voltage Gradient (DCVG)
- Alternating Current Voltage Gradient (ACVG)
  - *Pinpoints Coating Defects*
THIS COULD HAPPEN TO YOU!