Switchyard Berm Pipe Cathodic Protection Status

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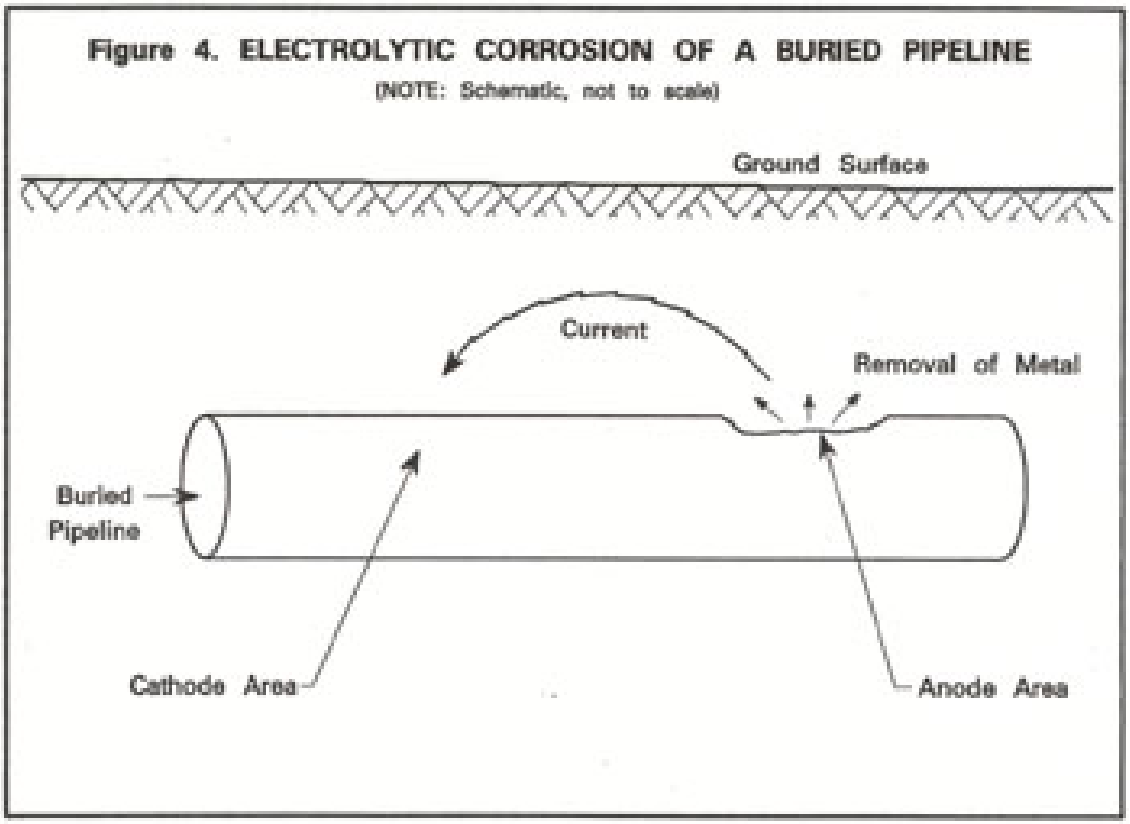
Weekly SY meeting

5 April 2016

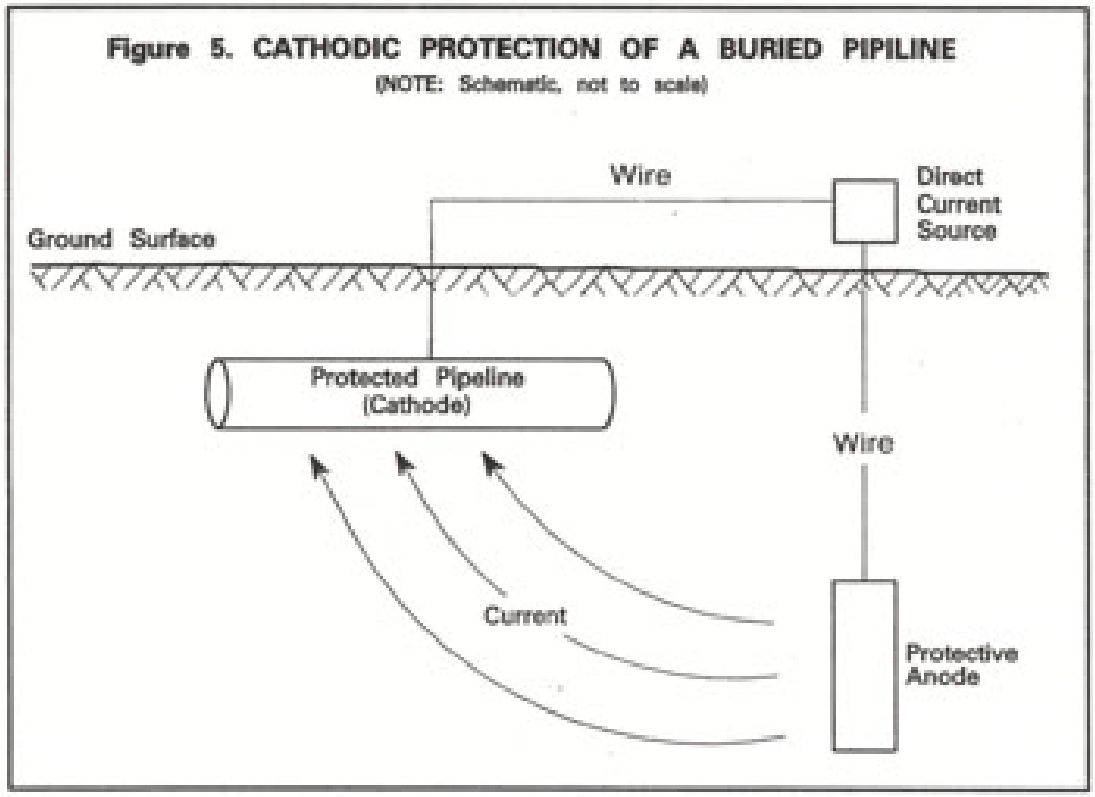
Berm Pipe Corrosion



Source: www.water.ca.gov

- Variation of salt concentration in soil/water create electric potential difference across surface of buried pipe.
- Current flow across potential difference causes electrolytic corrosion of metal.

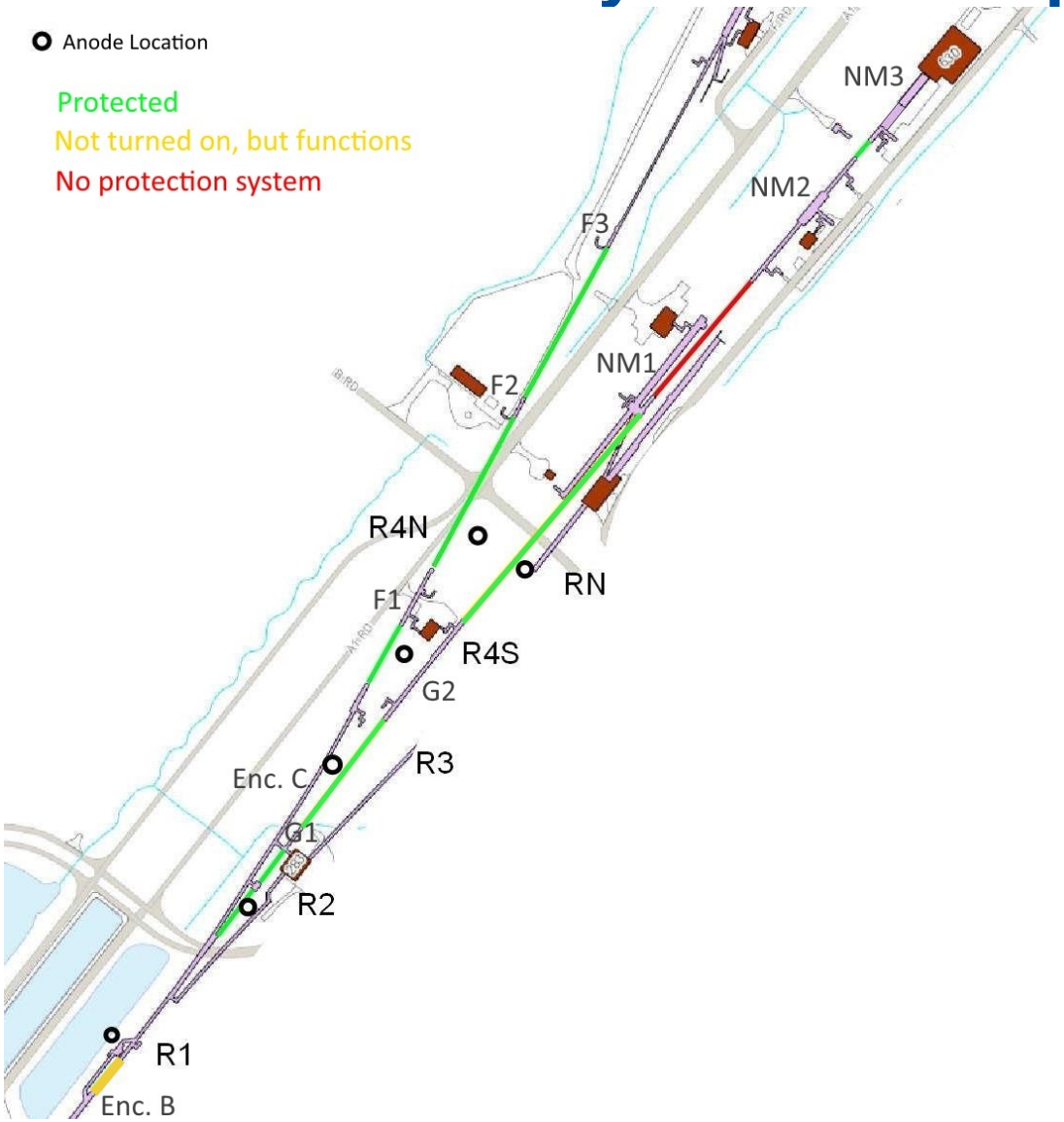
Impressed-Current Cathodic Protection



Source: www.water.ca.gov

- By burying a metal material and connecting a DC current source between the pipe and new material, a permanent anode/cathode system is formed.
- The electric potential forced by the DC current source causes current to flow toward the pipe from the anode, preventing ions from leaving the pipe (corrosion)

Status of Switchyard Berm Pipe Protection



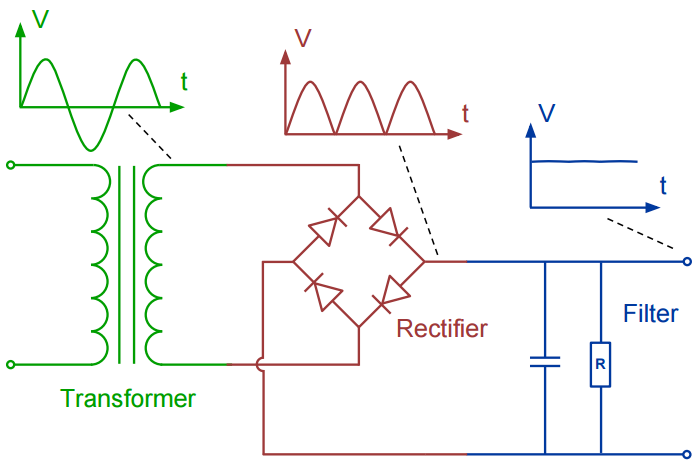
Rectifiers/Anodes:

- R1 (in Enc. B)
  - Enc. B- Enc. C
  - Enc. C- Enc. D
  - Concrete-encased pipe
- R2 (SSB)
  - Enc C. - G1
  - Enc D. - Enc. E
- R3 (SSB)
  - G1 - G2
- R4 (G2 service building)
  - Enc. C – F1 (R4S)
  - F1 – F2 (R4N)
  - F2 – F3 (R4N)
- RN (G2 service building)
  - G2 – NM1
  - Sleeved pipe
- Unprotected
  - NM1 - NM2

Source: Mike Geelhoed (adapted)

Fermilab

Rectifier DC Current Source



Source: Operations Concepts Rookie Book

Goal: monitor performance of CP system by measuring output current

Source: Mike Geelhoed (adapted)

Non-Invasive Anode Current Monitoring

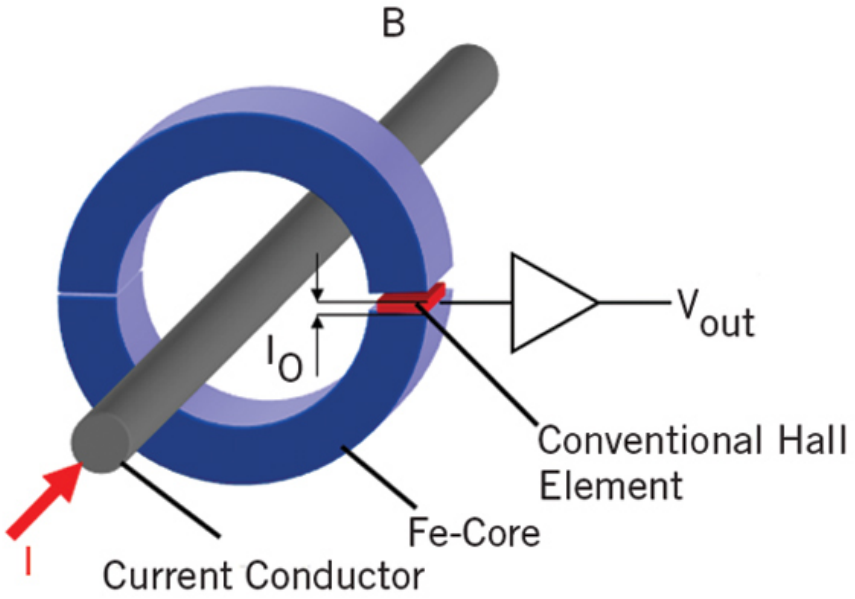
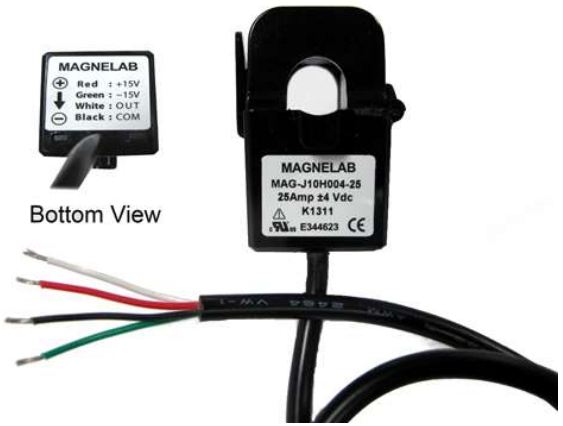


Fig. 3. Conventional Hall effect Current Sensor.

Source: www.powerelectronics.com

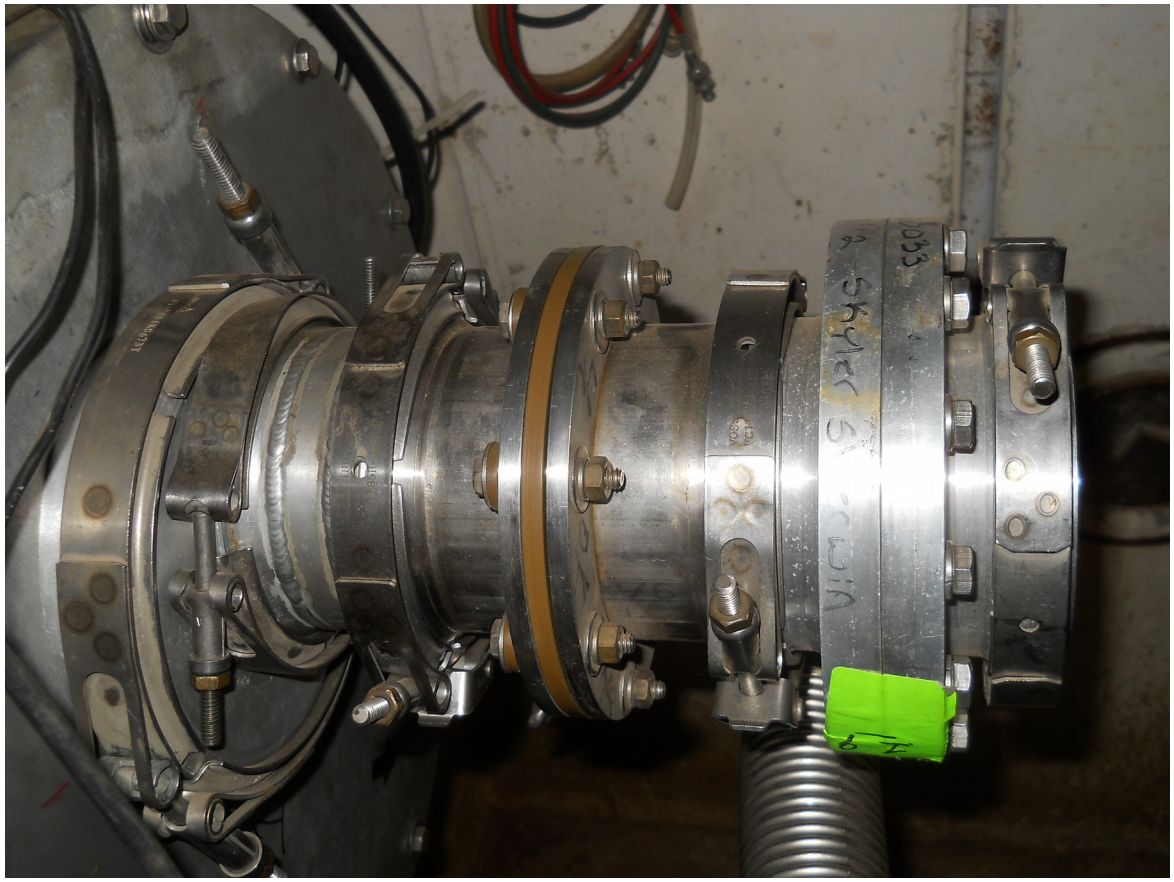
- Magnelab HCT-0010 sensor fits requirements
- Split-core, open-loop Hall effect sensor
- $60 each

- Current monitoring must be non-invasive: no modification to rectifier
- DC current ~1-20 A range
- Output must be ~0-10 V range (MADC)
- Goal is an ACNET parameter for anode current, alarmable (email nofity)



Source: www.aimdynamics.com

Beam Pipe – Berm Pipe Isolation



Source: Mike Geelhoed

- Torlon spacers electrically isolate the berm pipe from the beam pipe
- Question: is CP system safe to have on during tunnel access?
- Measure potential across Torlon. If not safe, tie CP into ESS or insulate.
- Pictured: upstream G2.

- **Update 5/11/16**: berm pipe to beam pipe potential ~mV, perfectly safe.

Goals

- Monitor rectifier currents via ACNET
- Verify with FESS that annual system inspections are scheduled and ongoing
- Measure potential across Torlon insulator (i.e. berm pipe to beam pipe)
- Implemement CP for NM1-NM2: very involved, contractor estimate, drilling, cable pulls, rectifier installation. Total cost ~$35,000 (not a quote, based on previous installation at SSB)

Cathodic Protection O&M Recommendations

- Monitor the DC outputs of each CP rectifier no less than once every 60 days. Changes in total DC amperage of ±10% without any proportional change in DC voltage merit attention.
- I also recommend that FNAL contract a NACE-certified CP Specialist to conduct annual CP maintenance inspections for this new installation and other critical facility structures equipped with CP rectifiers.

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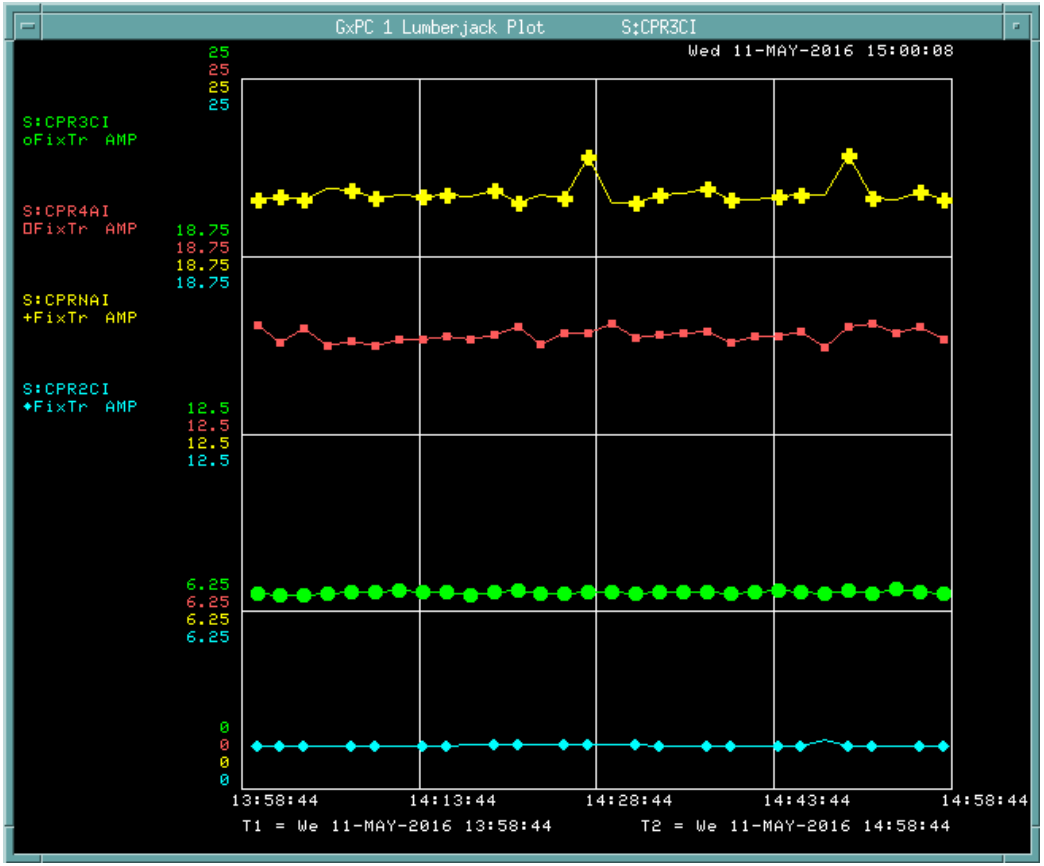
Source: Jeff Schramuk, CP Solutions

Monitor rectifier currents: complete!

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D97  Cathodic Protection          SET     D/A   A/D  Com-U ♦PTools♦
-<FTP>+ *SA♦ X-A/D  X=TIME     Y=D:Q024  ,D:Q024V ,D:Q024F
COMMAND ---- Eng-U  I= 0       I= 0      , 0      , 0
-<27>+  Once AUTO   F= 12      F= 800    , 20     , 800
spork ....  crews fish  mars  flomp BUNNY talos oper  griz  camac


 !---- SSB
 ! PS#2: 2 anode, 1 cathode
 S:CPR2CI     SSB CP R2 cath. current                1.513  AMP
 ! PS#3: 1 anode, 1 cathode
 S:CPR3CI     SSB CP R3 cath. current                6.812  AMP

 !---- G2
 ! PS#1: 1 anode, 1 cathode (RN)
 S:CPRNAI     G2 CP RN anode current                 20.65  AMP
 ! PS#4: 1 anode, 2 cathode (R4)
 S:CPR4AI     G2 CP R4 anode current                 16.12  AMP
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Fermilab

Backup slides: construction pictures

Source: CP Solutions

Distributed Vertical Anode Column

Drill well (~60 ft.)

Insert anode column

Fill with bentonite and coke

Distributed Vertical Anode Column

Install junction box at anode column

Pour concrete pad

Wire junction box

Distributed Vertical Anode Column

Dig trench for anode cable to service building

Wire anode cable to service building pull-box

Install and wire rectifier