AUCSC

Chapter 3

Installation of Impressed Current Cathodic Protection Systems

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PEOPLES

MAKING YOUR LIFE BETTER.

Summary

- What is an impressed current CP system and why use them?
- Types of ground beds
- Types of power sources
- Materials - anodes, cable, splices, others
- Selection of grounded sites
- Installation methods

What is impressed?

Uses an external source for driving voltage

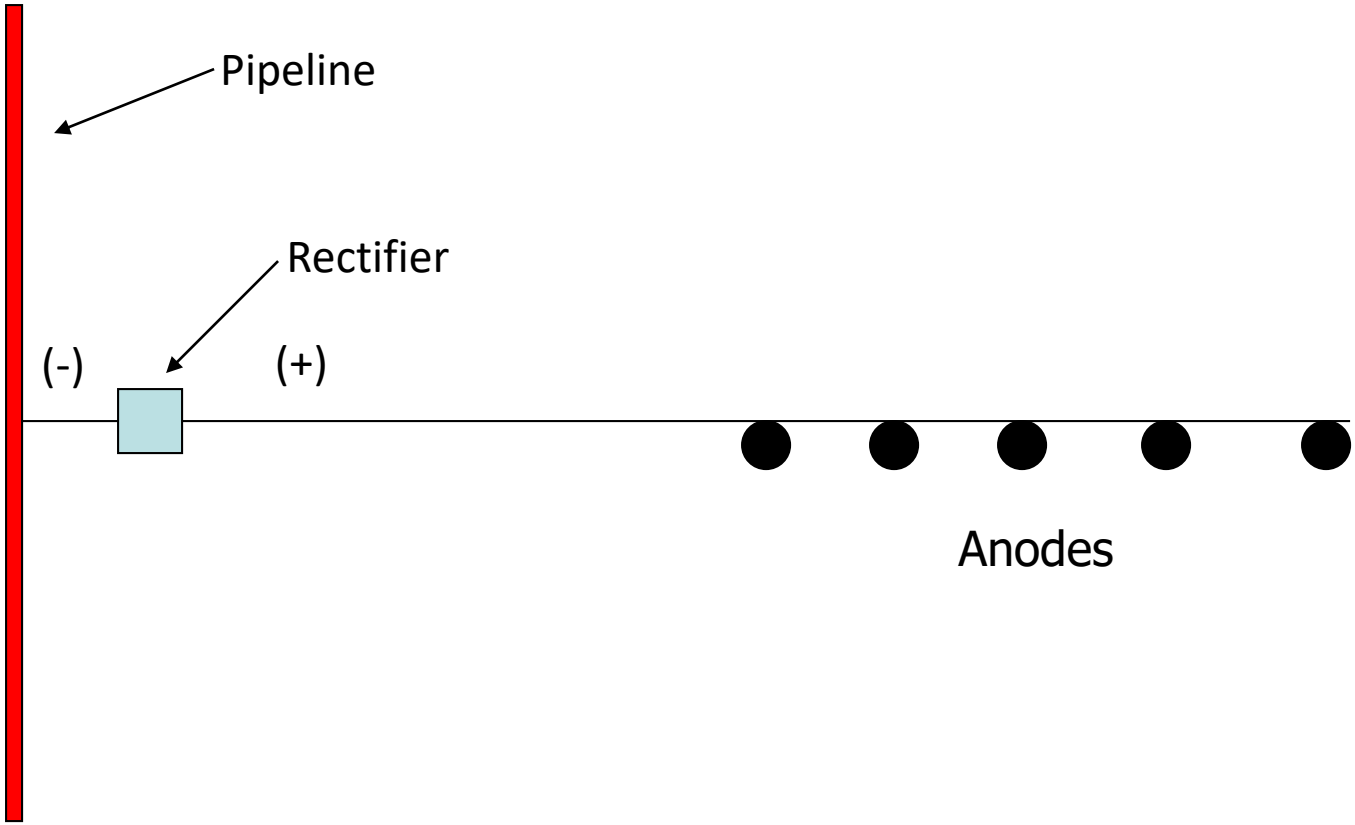
Why use impressed rather than galvanic?

- Higher current output
- Soil resistivity
- Cost
- Access to pipe

Types of Ground beds

Conventional - (Point)

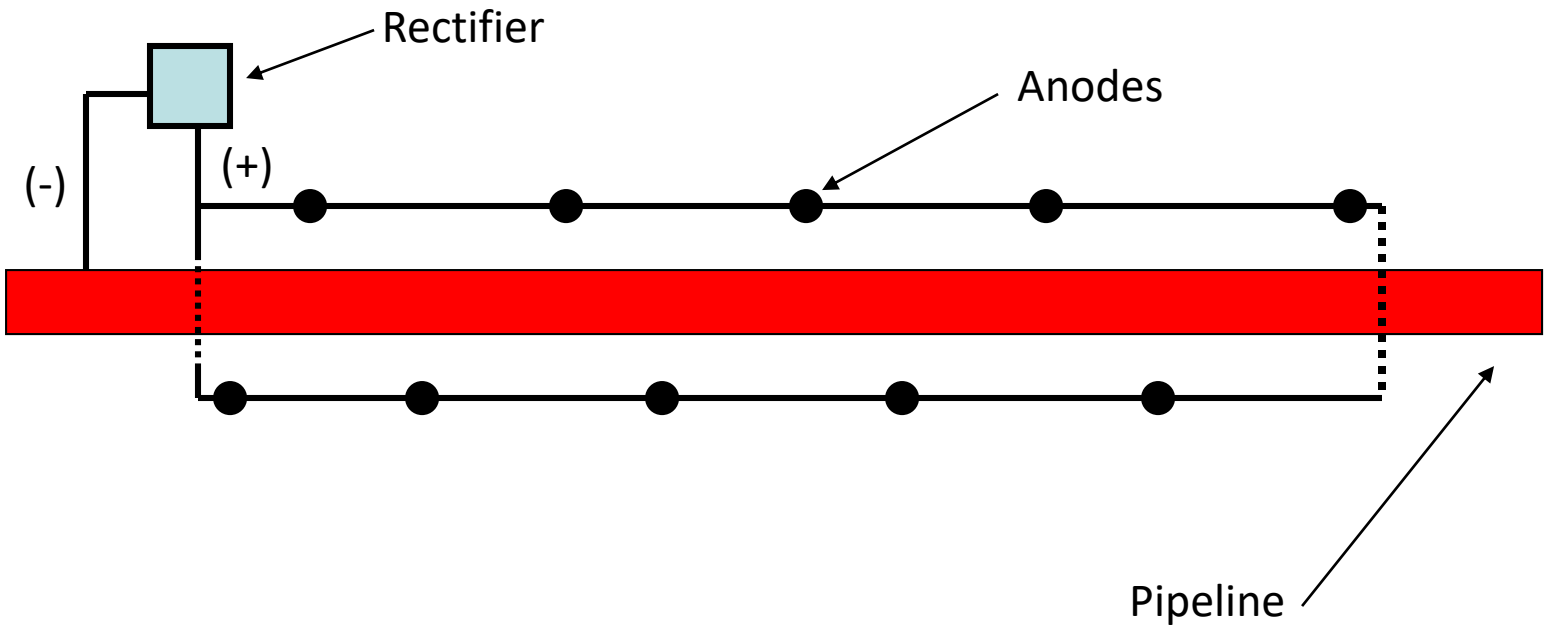
Remote and perpendicular most common



Types of Ground beds

Distributed

Close and parallel, usually in plants, more subject to damage, more expensive than a remote ground bed



Types of Ground beds

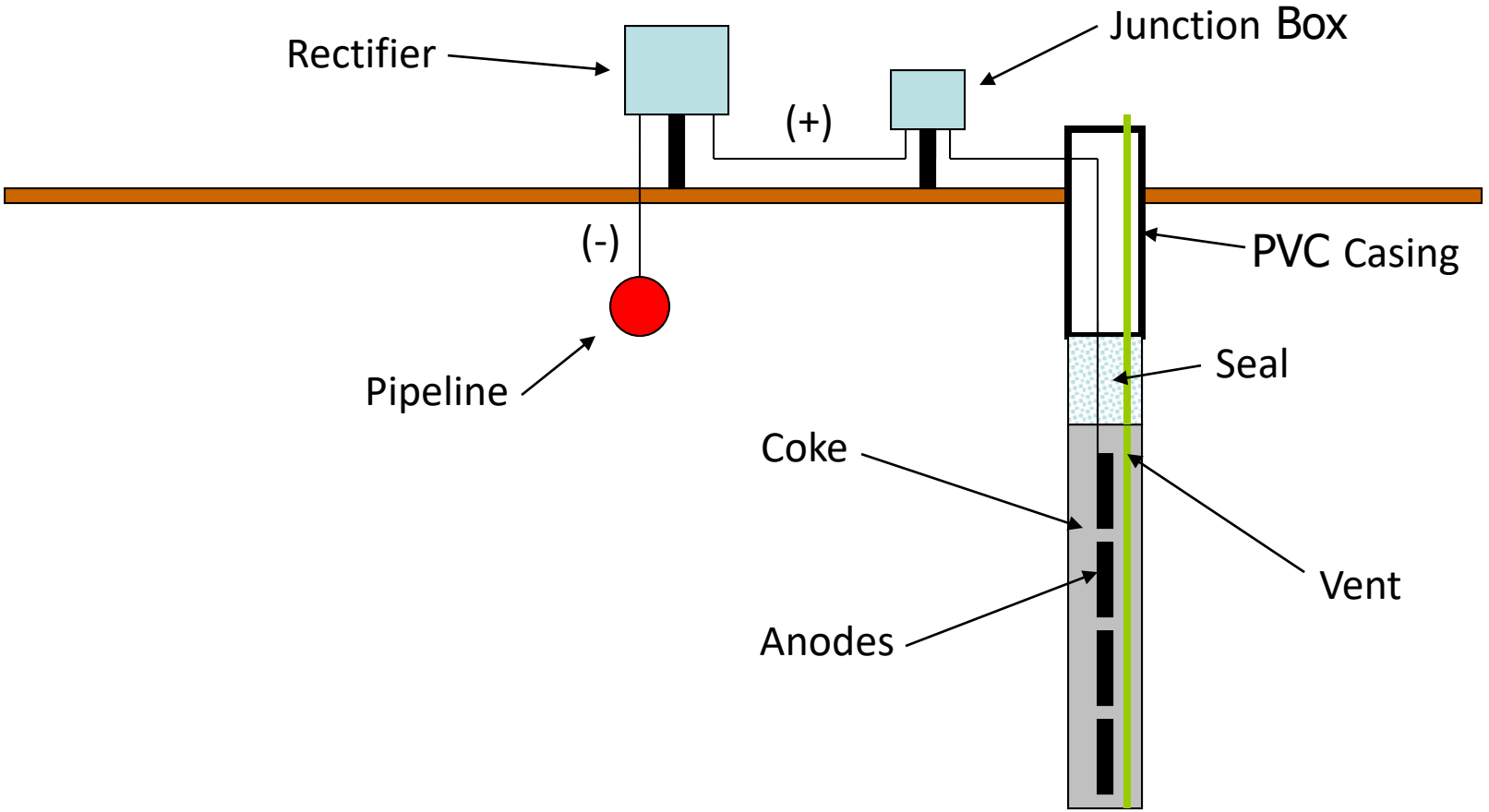
Deep

Multiple anodes in single drilled well

Uses – High soil resistivity areas

ROW problems

Congested areas



Conventional	Distributed	Deep
Most Common		Has Become Very Prevalent
Extended Current Distribution	"Localized" Application of Current	Extended Current Distribution
Common on Pipelines	Plants, Large Diameter Pipes, Terminals, Tanks	Pipelines, Plants, Terminals, Tanks
Requires ROW Perpendicular to Pipeline	Installed in Close Proximity to the Structure. Often More Care Required to Avoid Damage to the structure	Requires Less ROW / Space
	Less Stray Current	Useful in High Surface Zone Soil Resistivities
Can be Subject to Damage By Other Excavating and Animals	Most Susceptible to Damage From Plant and Piping Maintenance	Less Damage Prone, But Cannot be Repaired. Replaceable Systems Available.
Can be Augured, Drilled, Trenched, or Directionally Drilled	Can be Augured, Drilled, Trenched, or Directionally Drilled	Requires Mud Rotary or Air Drilling
	Should "Loop" the Header Cables	Possible Environmental Concerns
Typically Least Expensive	More Expensive	Most Expensive

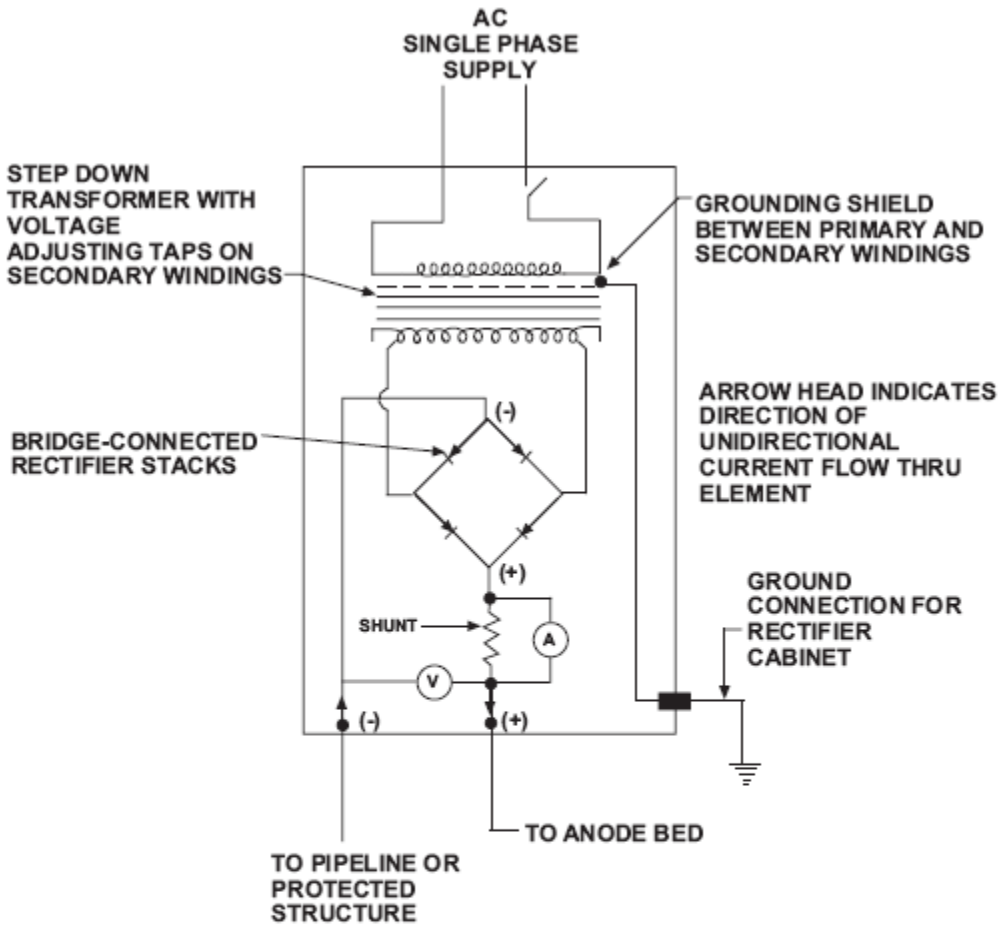
Types of Power Sources

- Rectifiers
- Solar panels
- Thermal electric generators (TEGs)
- Engine generators
- Turbine generators
- Wind generators

Rectifiers

- Converts AC to DC - *Takes AC from power distribution system and converts it to DC.*
- Uses a transformer and rectifying element
- Typical unit is constant voltage
- Other types include:
  - Constant current
  - Potential controlled


COARSE
FINE
CAUTION
HIGH VOLTAGE
SECONDARY

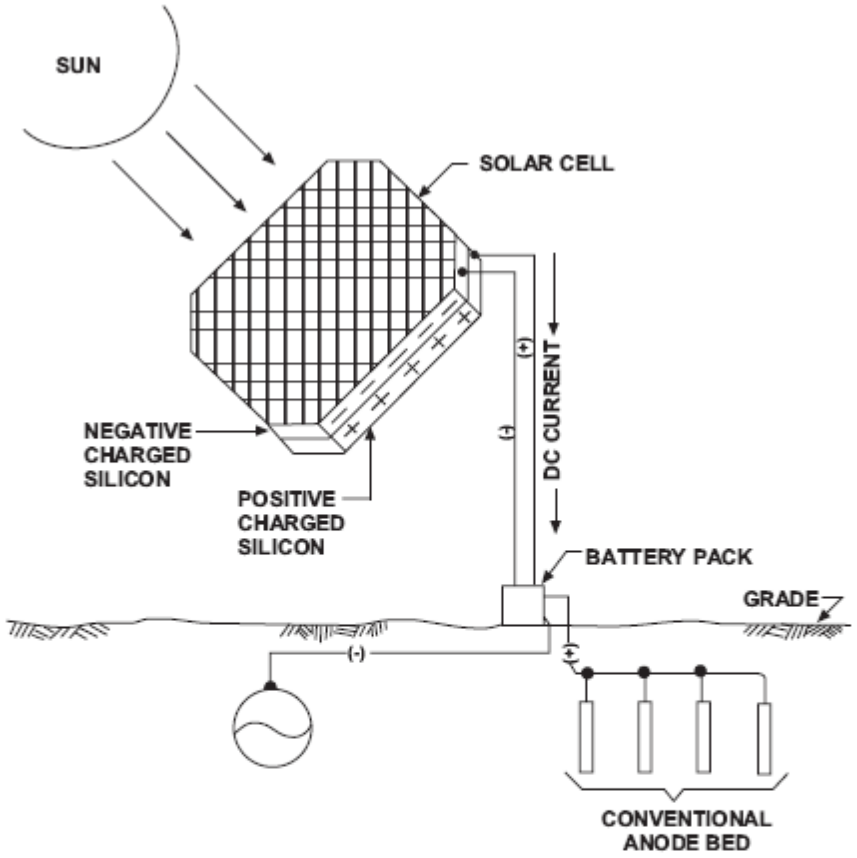


SINGLE PHASE RECTIFIER UNIT
SCHEMATIC DIAGRAM

FIGURE 3-1

Solar Panels

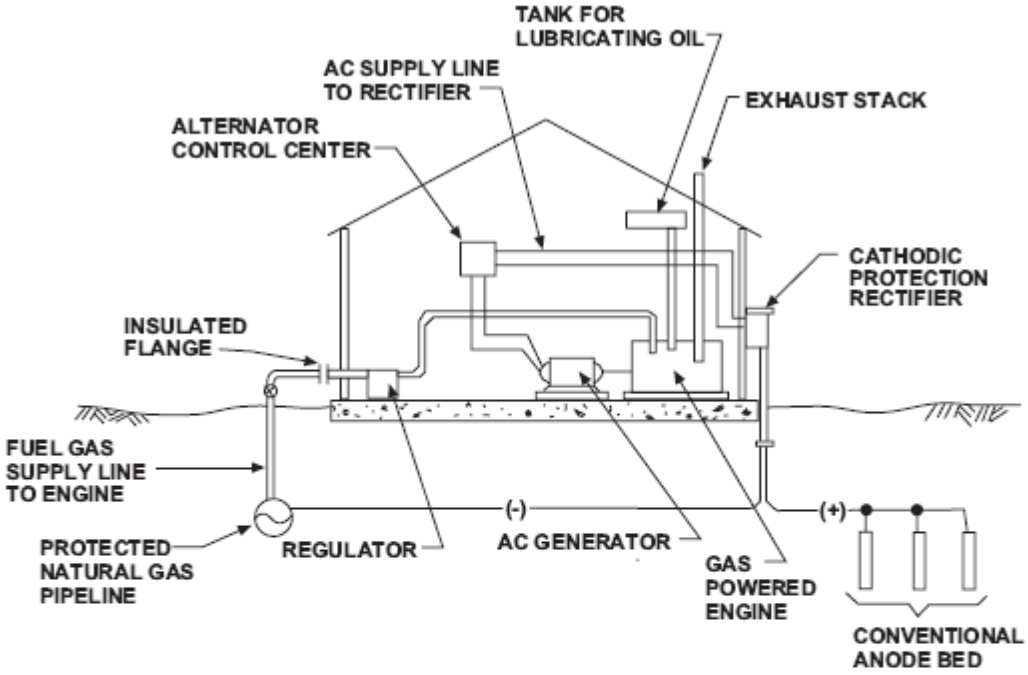
- Use solar cells to maintain a charge on a battery(s)
- Unit consists of solar cell, batteries, and a cabinet



SOLAR POWERED DC POWER SUPPLY FOR CATHODIC PROTECTION INSTALLATION

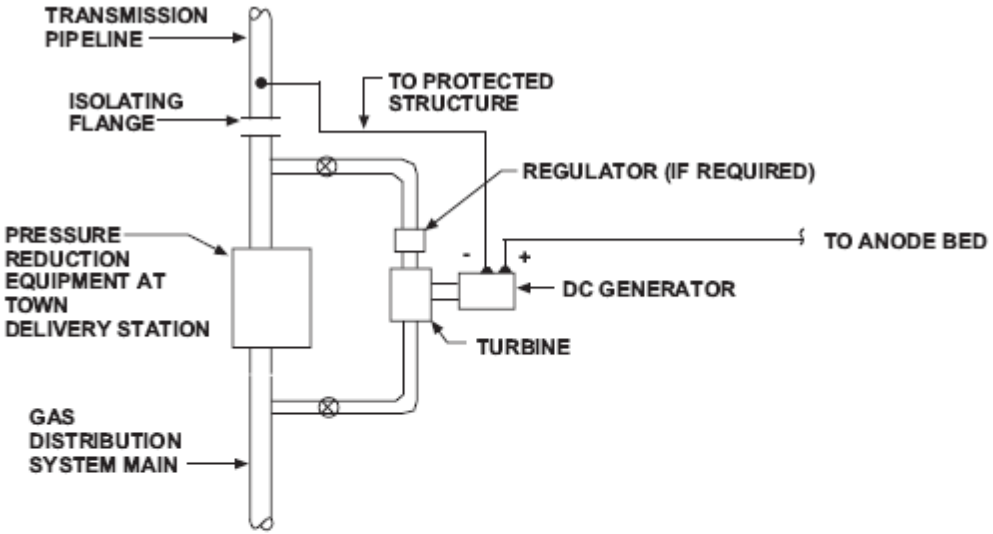
FIGURE 3-4


Laboratorio
de corrosión



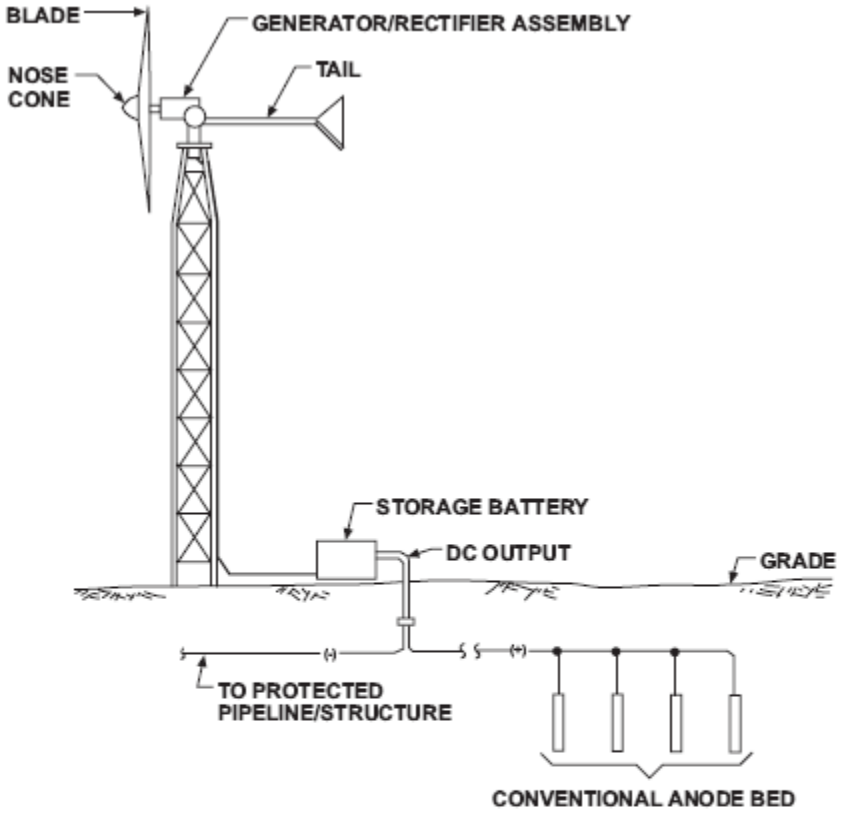
ENGINE GENERATOR SET
DC POWER SUPPLY
CATHODIC PROTECTION INSTALLATION

FIGURE 3-5



TYPICAL TURBINE GENERATOR SET INSTALLATION

FIGURE 3-6



WIND-POWERED DC POWER SUPPLY FOR CATHODIC PROTECTION INSTALLATION

FIGURE 3-7

Materials

- Anodes
  - Graphite*
  - High silicon cast iron*
  - Mixed metal oxide*
  - Polymer*
  - Platinum*
  - Magnetite
  - Scrap iron

* These anodes are readily available in canisters

Graphite Anodes

Sizes - 3”x30”, 3”x60”, 4”x80”

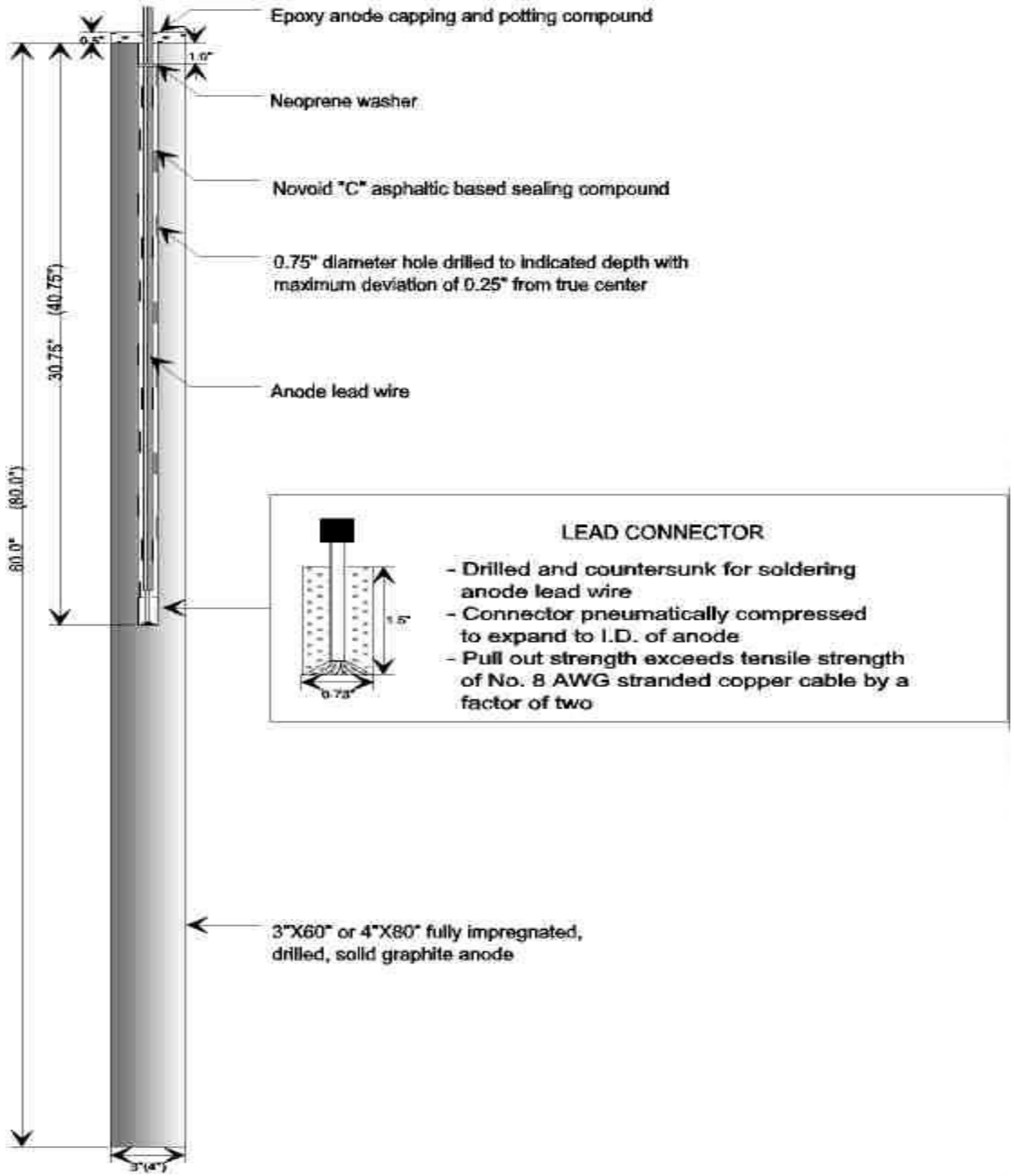
Treatment (Impregnation) – Wax, Linseed Oil, Resin

Connections - End or Center connection

Caps - Epoxy, Heat shrink, Both

Anodes are brittle, ***can be used in severe environments***

Center Connected Graphite Anode



High Silicon Cast Iron Anodes

Common Composition

Silicon (Si) – 14.5%

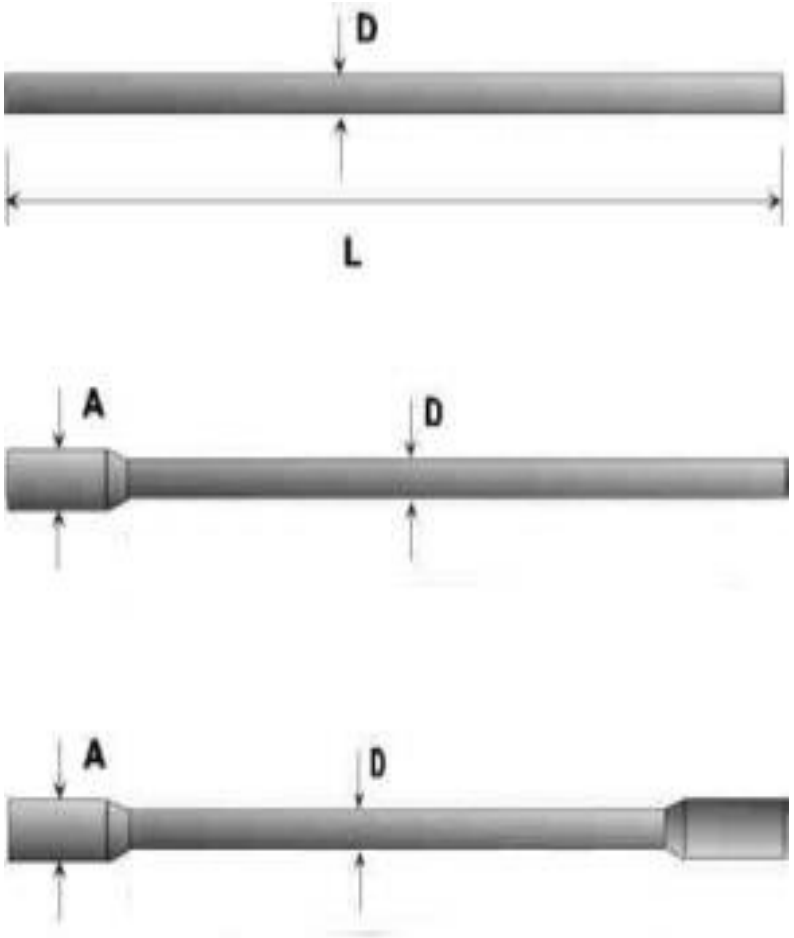
Chromium (Cr) – 4.5%

"Stick" anodes - 1-1/2" to 3" diameter, 60" long, some with enlarged heads, end connection

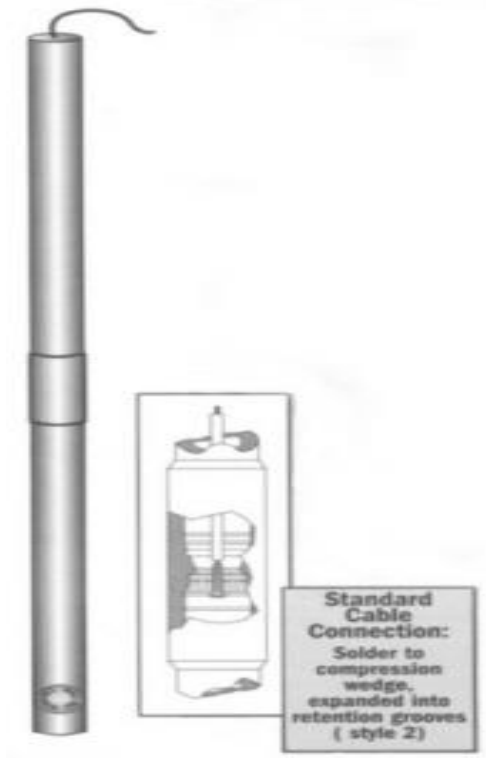
Tubular - 2.2" to 4.8" diameter, 60" to 84" long, some with expanded center, center connection

Other – Rods, buttons, bullets, pancakes

All types are brittle, ***used in soils and more hostile environments***



Stick Anodes



Tubular Anode

Mixed Metal Oxide Anodes

- Available in tubes and rods for standard ground beds
- Wire and ribbon for sea water and tank bottoms
- Ribbon is also used for protecting poorly coated pipelines. Placed parallel to the pipeline. May be in a “sock”

Platinum Anodes

- Platinum provided on Niobium wire
- Used successfully in sea water
- Usually applied to another cheaper metal like Titanium
- Tend to break down if voltage at anode surface is greater than 10 volts

Other Anode Material

Magnetite Anodes

- Popular in Europe, but rare usage in the United States, expensive

Scrap Iron

- Best if using abandoned parallel pipeline
- Continuity across anode difficult on long slender anodes
- Ground bed resistance and anode life hard to predict
- Consumption rate = 20 lbs/amp year

Coke Breeze

Coke breeze is the typical backfill material used in impressed current CP systems.

Used to lower anode resistance and increase anode life

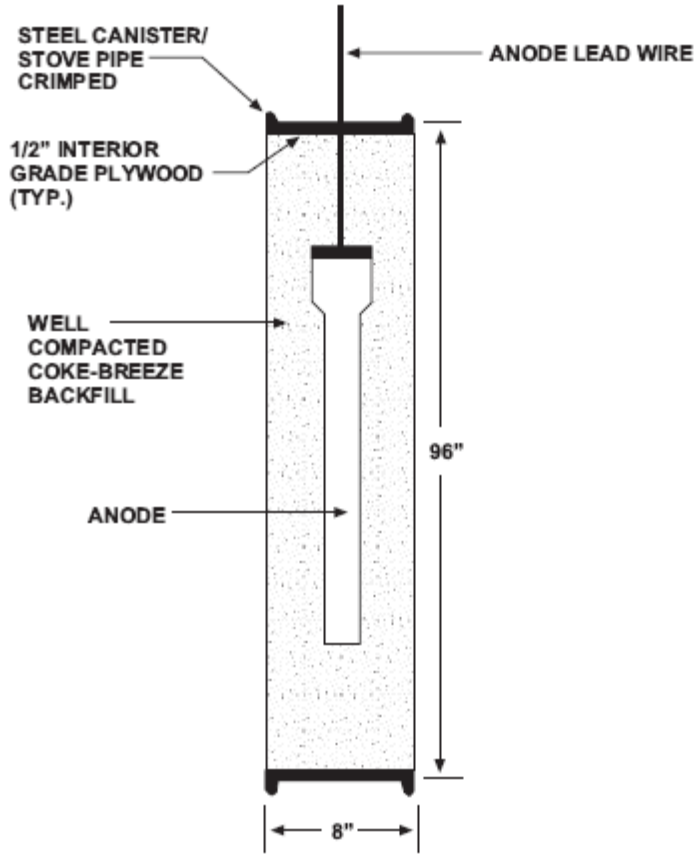
Metallurgical coke

- Derived from heating coal (coking) during the steel making process
- Usually adequate for most surface bed applications but generally requires tamping

Coke Breeze

Petroleum Coke

- Derived in refining process then calcined
- Quality control is much better
- Lower resistance
- Better surface contact
- Pumps easier for deep anode applications
- Some provided with surfactant to reduce water tension and promote compaction
- Coke available for conventional ground beds that do not require tamping
- Newest type does not require pumping
- More expensive



TYPICAL PREPACKAGED CANISTER ANODE

FIGURE 3-10

Other Materials

Cable

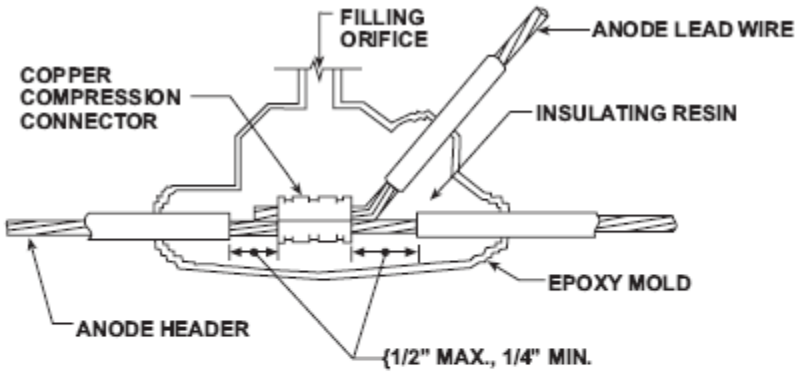
- HMWPE, Kynar, Halar

Splices

- Epoxy kits, heat shrink, tape, gel

Connectors

- Crimp type, split bolt, solder



TYPICAL ANODE LEAD WIRE TO ANODE HEADER CABLE EPOXY INSULATED SPLICE

FIGURE 3-14

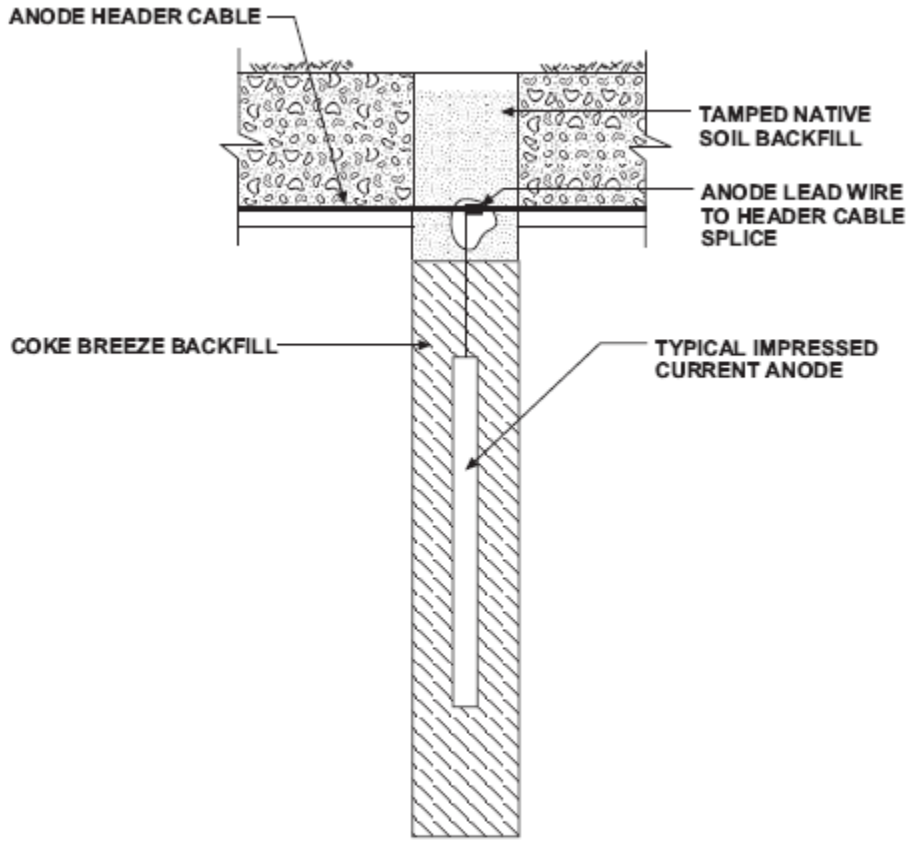
Selection of Ground Bed Sites

- System midpoint
- Soil resistivity – ***One of the most important factors***
- Soil moisture – Placing anodes in soils with high clay content can result in electro-osmosis (the loss of water in the soil near the anode)
- Power supply
- Right of way availability
- Interference problems
- Accessibility (Construction and maintenance)
- Vandalism and safety

Installation Methods

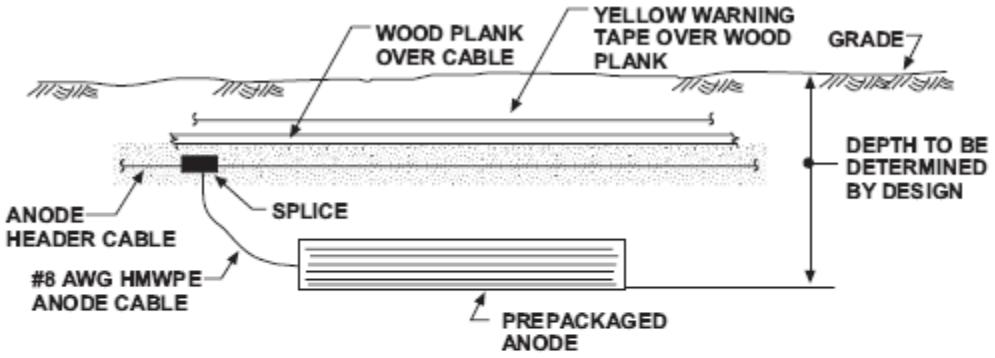
Surface ground beds (Anodes) – *Can be installed horizontal or vertical*

- Auger (best) *The depth of the auger hole is based on design calculations and the type of anode*
- Backhoe (Usually horizontal)
- Horizontally directionally drill (HDD)
- Tamp coke (Metallurgical) or use canisters
- Trench
- Warning tape and/or conduit
- Loop system
- Test cable at end of runs
- Junction boxes for multiple anode strings



TYPICAL VERTICAL ANODE INSTALLATION

FIGURE 3-15



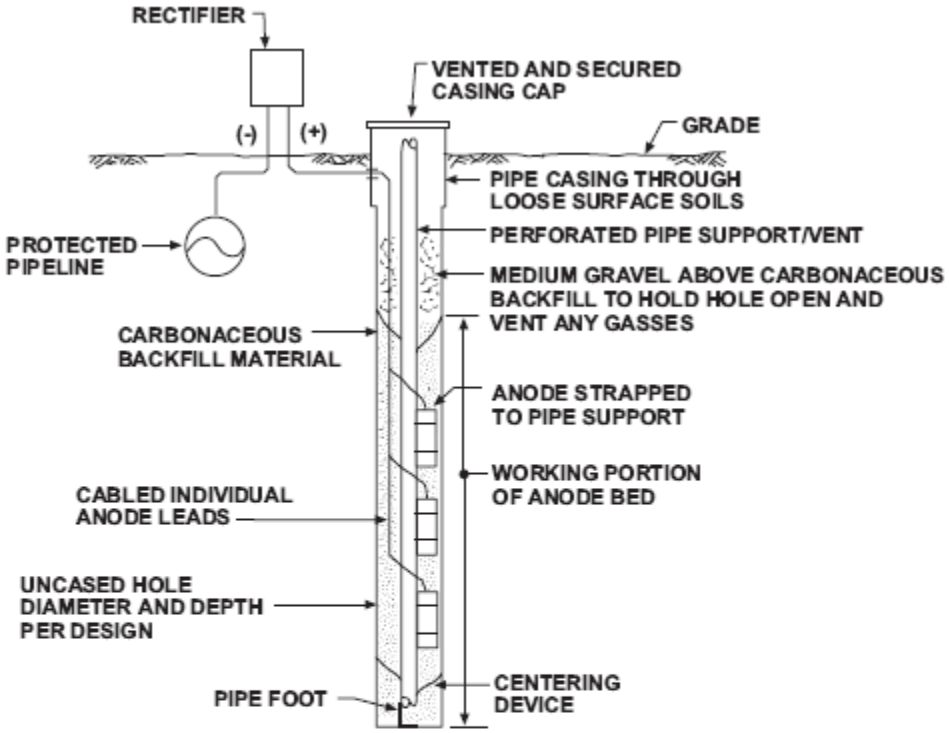
TYPICAL HORIZONTALLY INSTALLED PREPACKAGED ANODE

FIGURE 3-17

Installation Methods

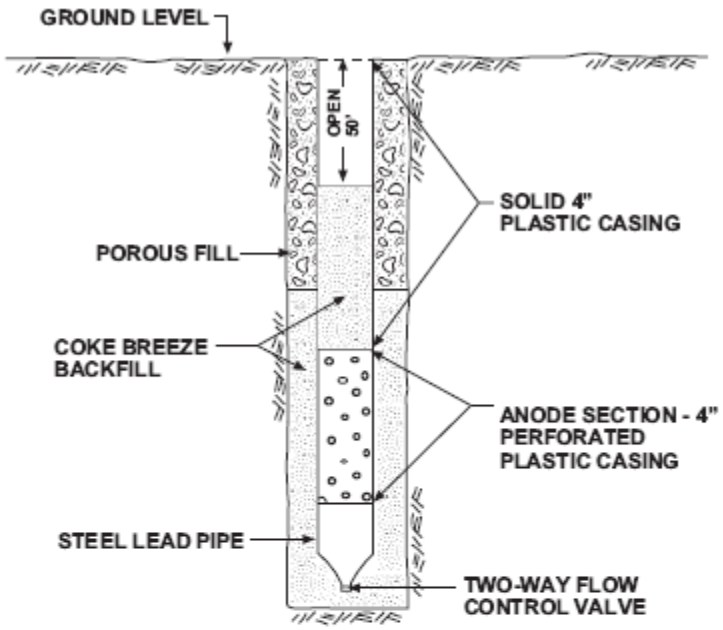
Deep anode ground beds

- Require drilling rig (Either air or fluid rotary)
- Install surface casing for environmental, construction, and shielding purposes
- Conduct electrical log of hole
- Lower anodes by cable (Usually)
- Individual anode leads
- Best if coke breeze is pumped
- Well must be vented
- Provide junction box with shunts
- Seal well



DEEP ANODE BED DESIGN USING PERFORATED PIPE SUPPORT/VENT AND CARBONACEOUS BACKFILL

FIGURE 3-19



CAPSULE TYPE DEEP ANODE INSTALLATION

FIGURE 3-21

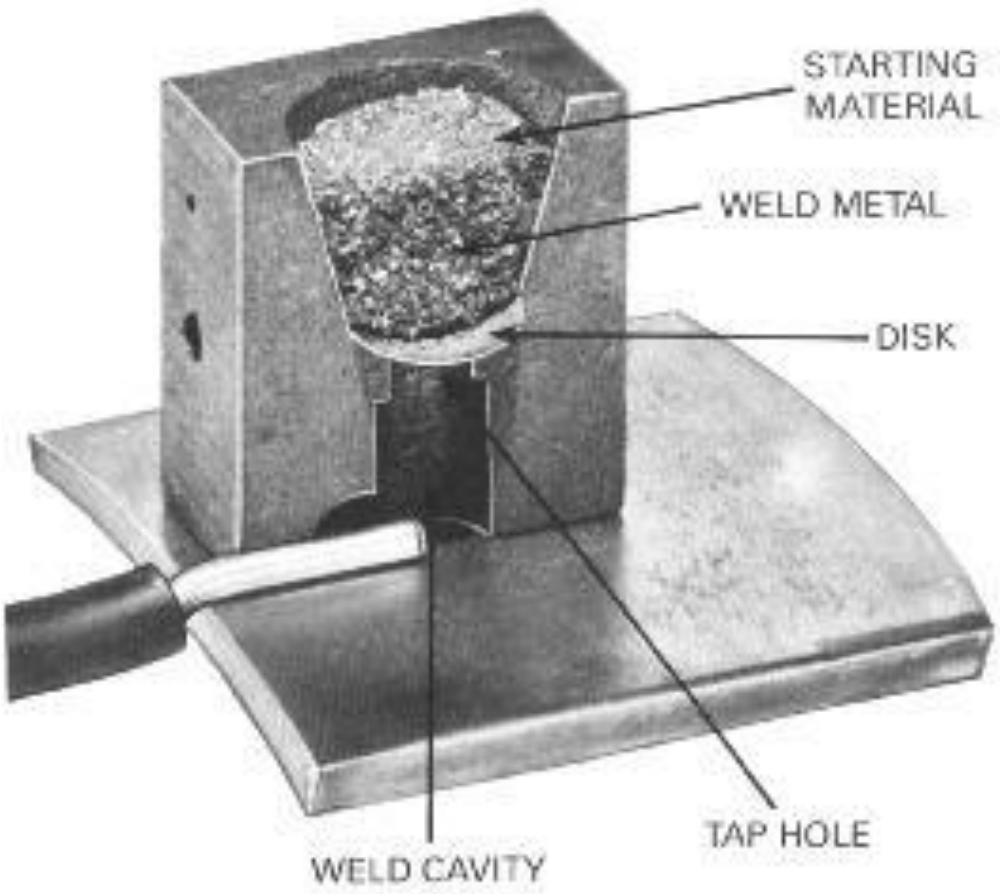
Typical Anode Junction Box

Installation Methods

Connection to the Pipe

- Exothermic weld method
- Uses graphite mold filled with copper oxide and aluminum
- Always wear gloves, boots, and safety googles
- Use UT to measure wall thickness before attempting weld

Typical Thermite Weld



Questions?