APPALACHIAN UNDERGROUND CORROSION SHORT COURSE

AUCSC

Education and Training for Corrosion Control

Intermediate Course

CHAPTER 2

INSTALLATION OF GALVANIC ANODES

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corrpro®

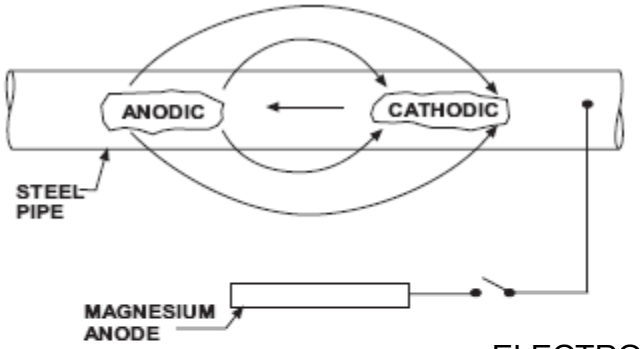
An Aegion™ Company

Appalachian Underground Corrosion Short Course
West Virginia University
Morgantown, West Virginia

Installation of Galvanic Anodes

- Brief review of fundamentals
- Normal applications
- General physical and electrical characteristics of common underground galvanic anodes
- Guidelines for field installations

"OPEN CIRCUIT" ANODE IS NOT RECOGNIZED

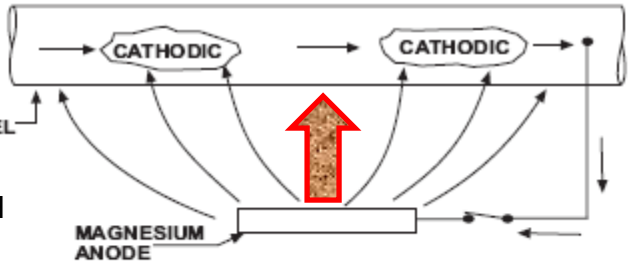


NO CP

ELECTROLYTIC PATH

CONDITION 1:

SWITCH OPEN IN MAGNESIUM ANODE CIRCUIT. NO CATHODIC PROTECTION. CORROSION CURRENT FLOW FROM ANODIC AREA TO CATHODIC AREA OF CORROSION CELL SHOWN BY LINES AND ARROWS. RETURN CIRCUIT THROUGH PIPE.



ELECTROLYTIC PATH

Metallic Path

CONDITION 2:

SWITCH CLOSED IN MAGNESIUM ANODE CIRCUIT. CATHODIC PROTECTION APPLIED. CATHODIC PROTECTION CURRENT FLOW SHOWN BY LINES AND ARROWS. PREVIOUSLY ANODIC AREA HAS BECOME CATHODIC.

CP APPLIED

"CLOSED CIRCUIT" ANODE IS NOW RECOGNIZED

BASIC CONCEPT OF CATHODIC PROTECTION WITH GALVANIC ANODES

FIGURE 2-1

Practical Galvanic Series

Material	Potential*
PURE MAGNESIUM	-1.75
MAGNESIUM ALLOY	-1.60
ZINC	-1.10
ALUMINUM ALLOY	-1.00
MILD STEEL (NEW)	-0.70
MILD STEEL (OLD)	-0.50
CAST / DUCTILE IRON	-0.50
STAINLESS STEEL	-0.50 to + 0.10
COPPER, BRASS, BRONZE	-0.20
GOLD	+0.20
CARBON, GRAPHITE, COKE	+0.30

* Potentials with respect to saturated Cu-$CuSO_4$ electrode

Galvanic Systems
Used Where

- Small amounts of current required
- Soil resistivity relatively low
- Constraints on use of impressed current
- Spot requirements

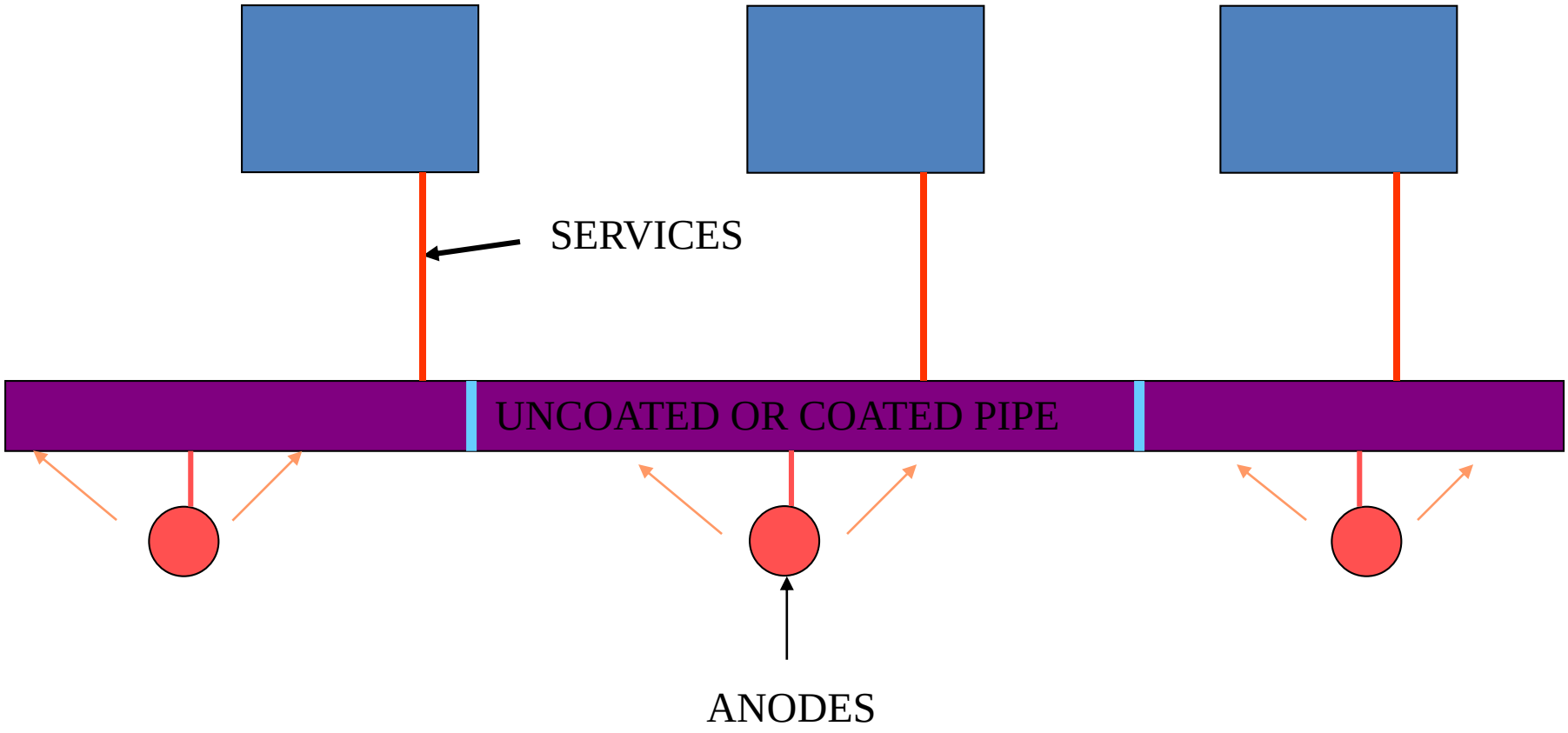
Advantages of Galvanic Anode Systems

- No external power required
- Easy to install
- Minimum of anodic interference
- Anodes can be readily added
- Minimum of maintenance
- Self regulating
- Minimum right-of-way easement cost
- Efficient use of protective current

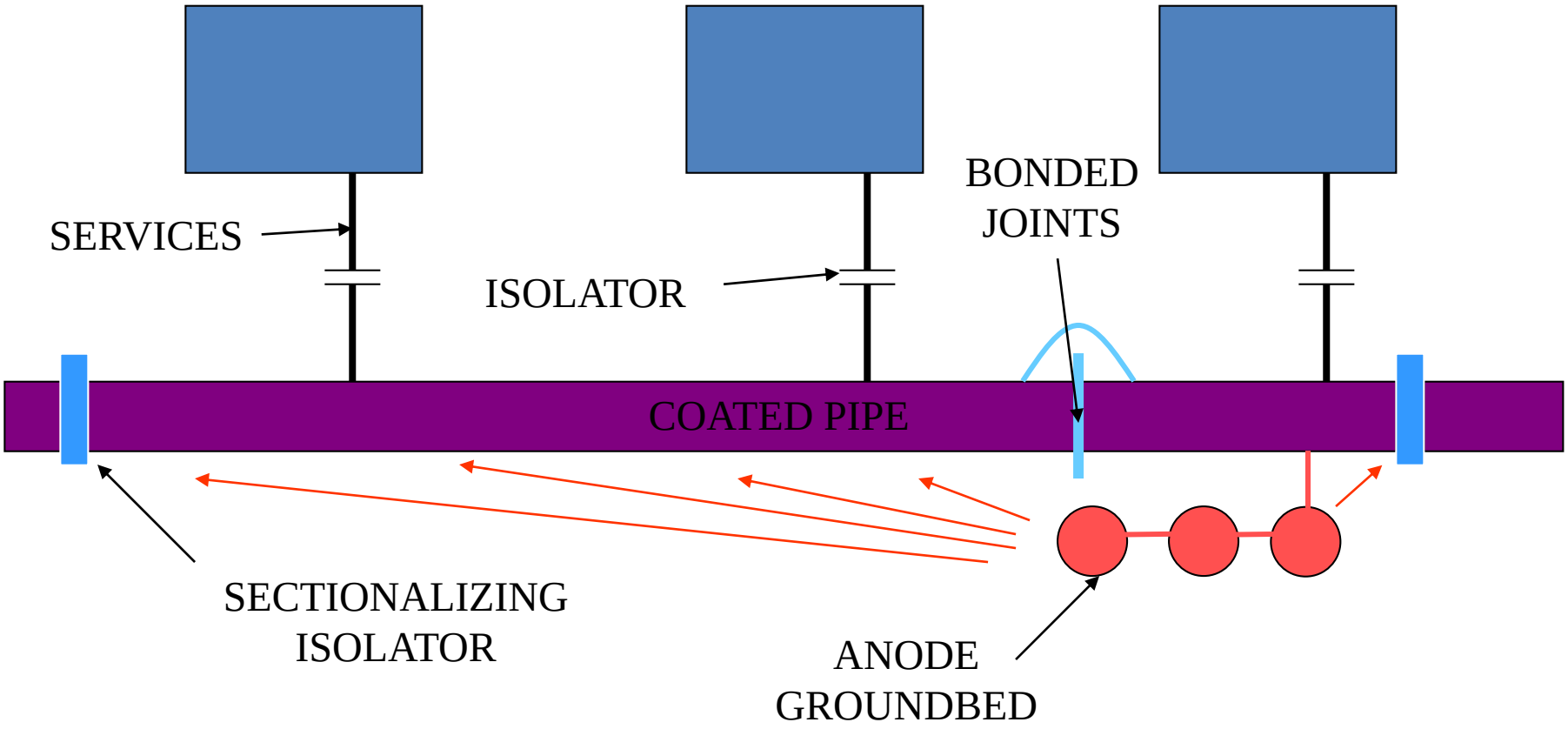
Disadvantages of Galvanic Anode Systems

- Limited driving potential
- Lower/limited current output
- Can be ineffective in high-resistivity environments
- Poorly-coated structures require many anodes
- Not economical where large currents required
- May not be effective in dynamic stray current areas

Distributed Galvanic CP System



Single Groundbed Galvanic CP System



MAGNESIUM ANODES

- Highest driving potential
- Many different sizes and shapes
- Generally used where soil resistivity between 1,000 and 5,000 ohm-cm

TABLE 2-1

COMMON ALLOY SPECIFICATIONS - MAGNESIUM

Element	High Potential	Grade A	Grade B	Grade C
Al	0.010% max	5.3 to 6.7%	5.3 to 6.7%	5.0 to 7.0%
Mn	0.50 to 1.30%	0.15 to 0.70%	0.15 to 0.70%	0.15 to 0.70%
Zn	0	2.5 to 3.5%	2.5 to 3.5%	2.0 to 4.0%
Si	0.05 % max	0.10% max	0.30% max	0.30% max
Cu	0.02% max	0.02% max	0.05% max	0.10% max
Ni	0.001% max	0.002% max	0.003% max	0.003% max
Fe	0.03 % max	0.003% max	0.003% max	0.003% max
Other	0.05% each or 0.30% max total	0.30 % max	0.30 % max	0.30 % max
Magnesium	Remainder	Remainder	Remainder	Remainder
Solution Potential	-1.80 V	-1.55 V	-1.55 V	-1.55 V


GALVOMAG
HIGH POTENTIAL
2 UNITS TYPE 703
MAGNESIUM
ANODE
WITH BACKFILL
PACKAGED BY
CATHODIC PROTECTION SERVICE
HOUSTON
TULSA - FARMINGTON - LOS ANGELES - MIDLAND
CORPUS CHRISTI - NEW ORLEANS - DENVER

- Sodium sulfate
- Gypsum
- Bentonite

Zinc

- Many shapes and sizes
- Best in low resistivity environment < 2,000 ohm-cm

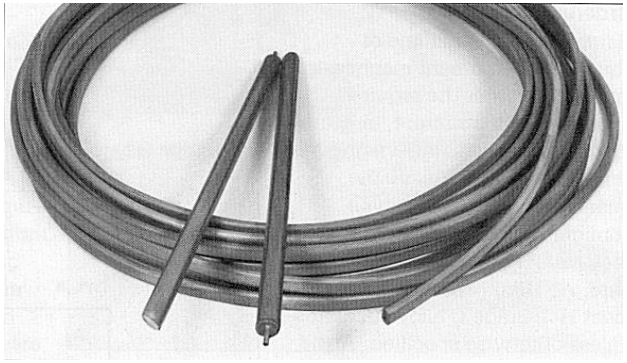
Note: Cadmium is a known carcinogen and thus this alloy should not be used in Underground Applications

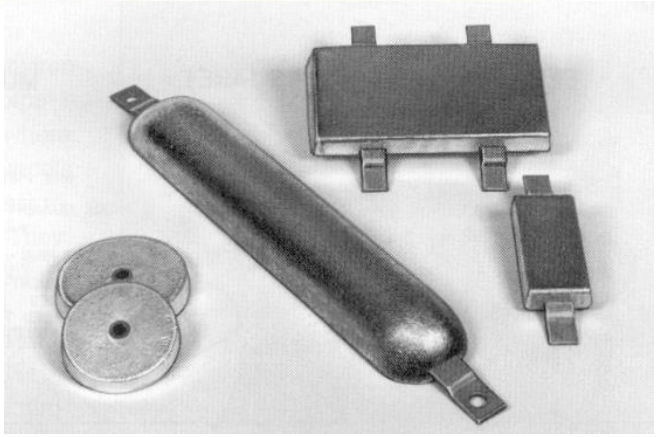
TABLE 2-2

COMMON ALLOY SPECIFICATIONS - ZINC

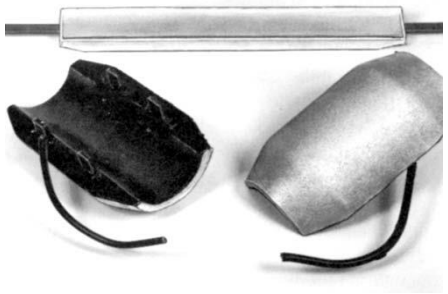
Zinc (Mil-A 18001)		Zinc (ASTM B418-67 Type II)	
Seawater Use		Underground Use	
Element	Percent	Element	Percent
Aluminum	0.1 to 0.3%	Special high-grade Zinc	99.99% pure
Cadmium	0.025 to 0.06%		
Iron	0.005% max		
Special high-grade zinc	Balance		
Solution potential	-1.10 V	Solution potential	-1.10 V

Zinc Anodes





Note: None of these Aluminum Anode alloys work in Underground Applications – The anode will passivate and not deliver effective CP



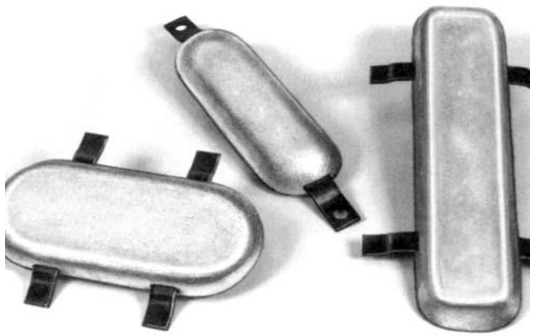


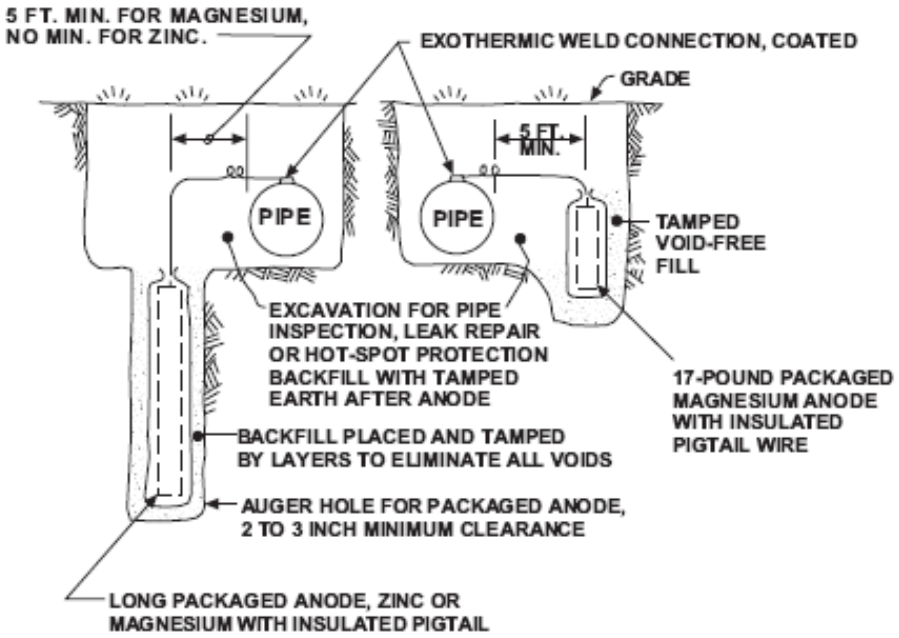
TABLE 2-3

COMMON ALLOY SPECIFICATIONS - ALUMINUM

Element	Seawater Galvalum I	Saline Mud Galvalum II	Seawater Brackish Saline Mud Galvalum III
Zinc	0.35 to 0.50%	3.5 to 5.0%	3.0%
Silicon	0.10% max	-	0.1%
Mercury	0.035 to 0.048%	0.035 to 0.048%	-
Indium	-	-	0.015%
Aluminum	Remainder	Remainder	Remainder
Solution Potential	-1.10 V	-1.10 V	-1.10 V

Alloy	Potential mVolts, CSE	Efficiency Amp-h/lb	Consumption Rate Lb/A-y	Uses
Al-Zn-Hg	-1050	1250-1290 95%	7.0-6.8	SW, brackish water, saline mud
Al-Zn-Sn	-1100	420-1180 95%	20.8-7.4	
Al-Zn-In	-1100	760-1090 95%	11.5 – 8.0	
Zn (MIL spec)	-1100	370 90-95%	23.7	Water, soil
Zn (ASTM)	-1050	370 90-95%	23.7	
Mg (H1)	-1550	500 50%	17.5	
Mg (HP)	-1700 to -1800	550 50%	17.5	

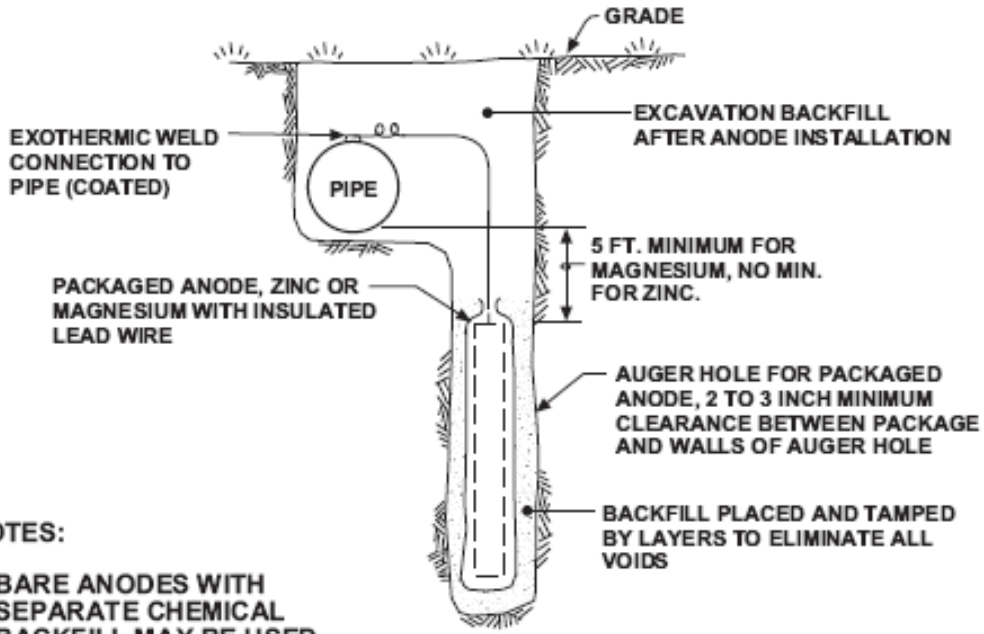

INSTALLATION



TYPICAL INSTALLATION OF
PROTECTION WITH GALVANIC ANODES

FIGURE 2-2

Although this slide and in your
Book indicate by the drawing
To connect the anode directly
To the pipe…..Do not! Utilize
An approved test station…This
Will allow the circuit to be
Interrupted for survey & troubleshooting
purposes

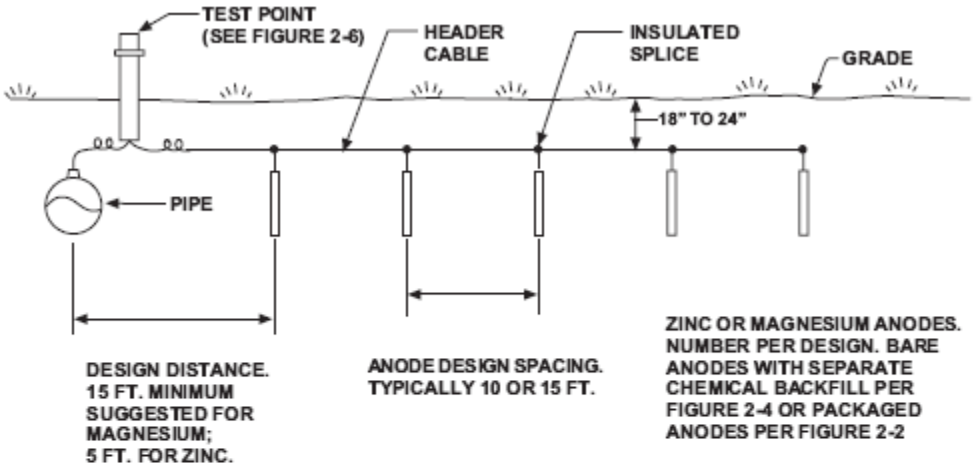


NOTES:

1. BARE ANODES WITH SEPARATE CHEMICAL BACKFILL MAY BE USED PER FIGURE 2-4.
2. MULTIPLE ANODE INSTALLATIONS MAY ALSO BE MADE WITH ALL ANODES BELOW PIPE BUT OTHERWISE IN GENERAL ACCORD WITH FIGURE 2-5.
3. IF NECESSARY, AUGER HOLE MAY BE ANGLED SLIGHTLY

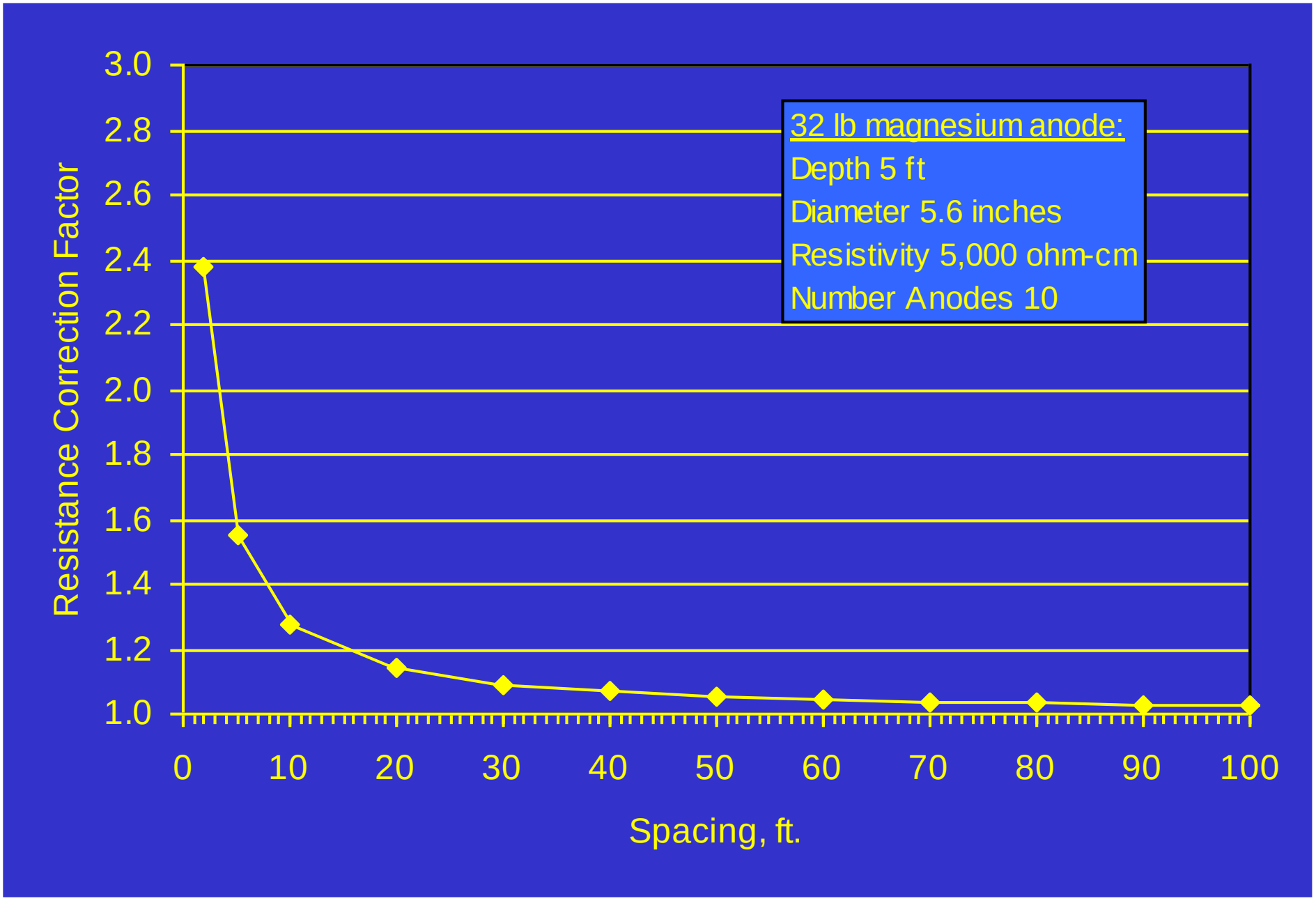
TYPICAL INSTALLATION OF GALVANIC ANODES WHERE LATERAL SPACE IS LIMITED

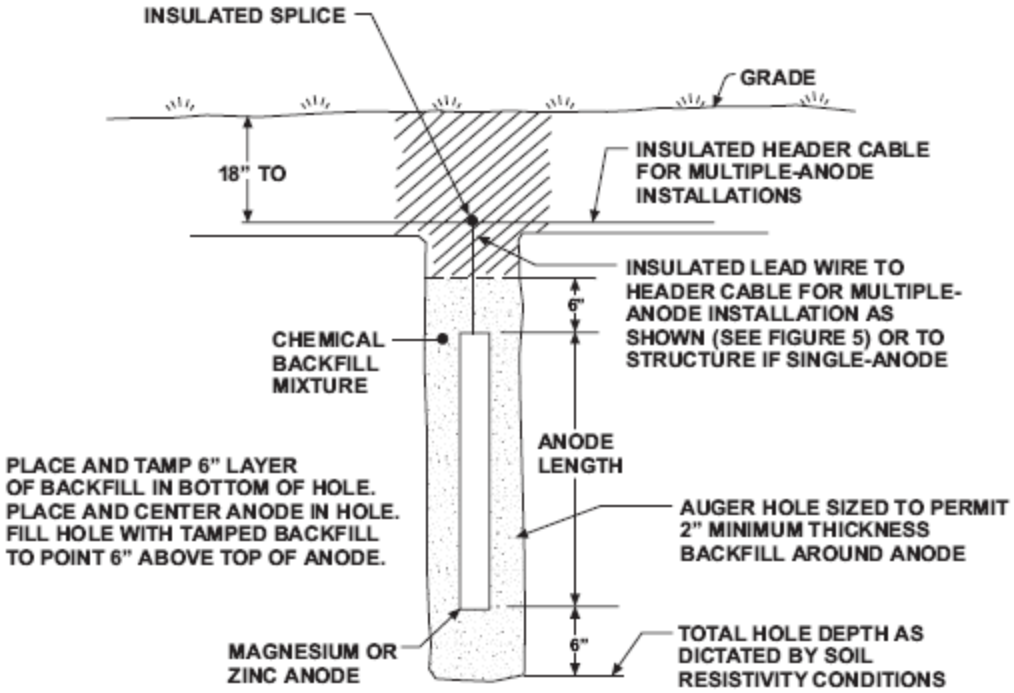
FIGURE 2-3



MULTIPLE INSTALLATION OF GALVANIC ANODES

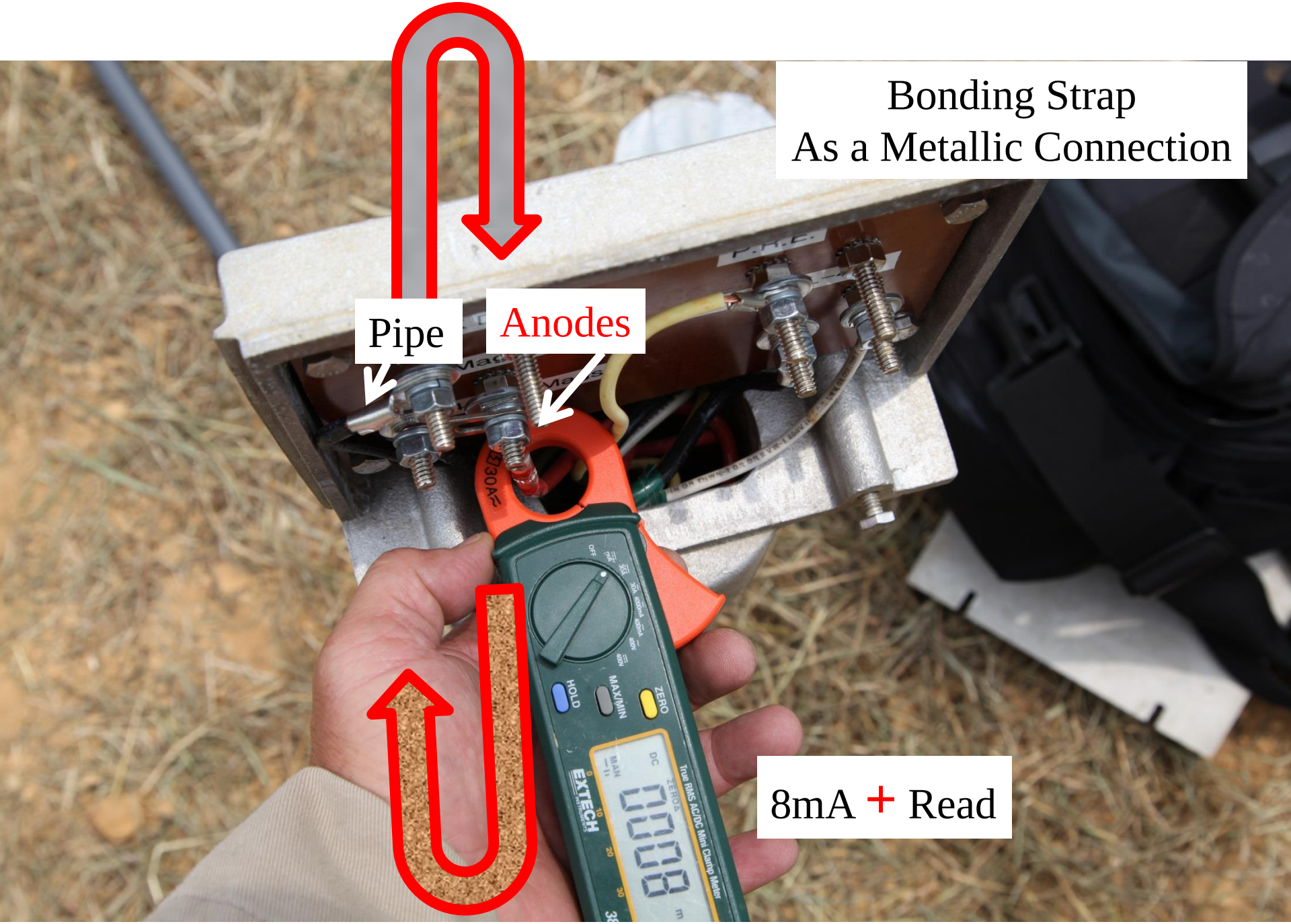
FIGURE 2-5


3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
Resistance Correction Factor
0
10
20
30
40
50
60
70
80
90
100
Spacing, ft.
32 lb magnesium anode:
Depth 5 ft
Diameter 5.6 inches
Resistivity 5,000 ohm-cm
Number Anodes 10

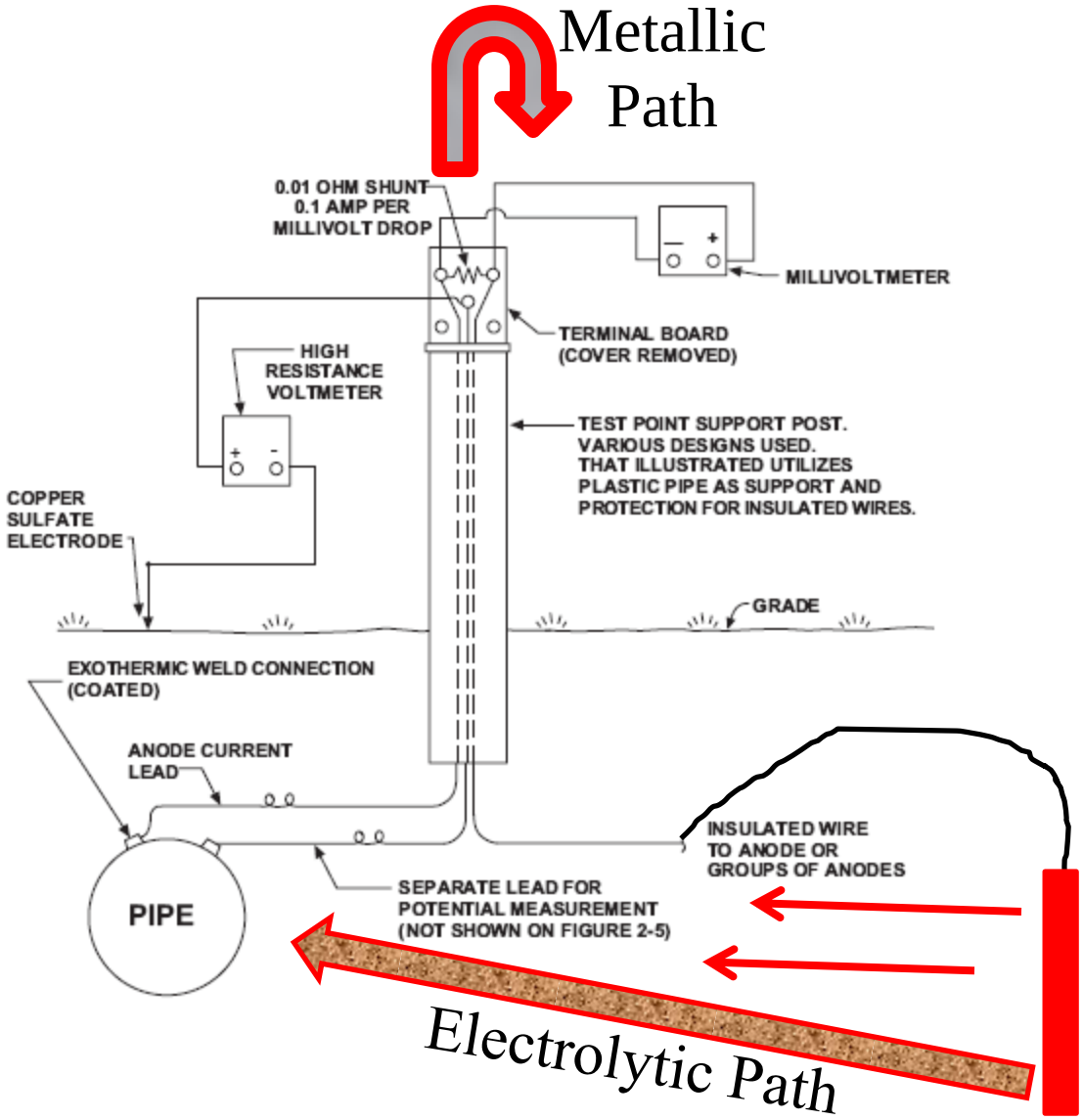


TYPICAL INSTALLATION OF BARE GALVANIC ANODES WITH SEPARATE CHEMICAL BACKFILL

FIGURE 2-4

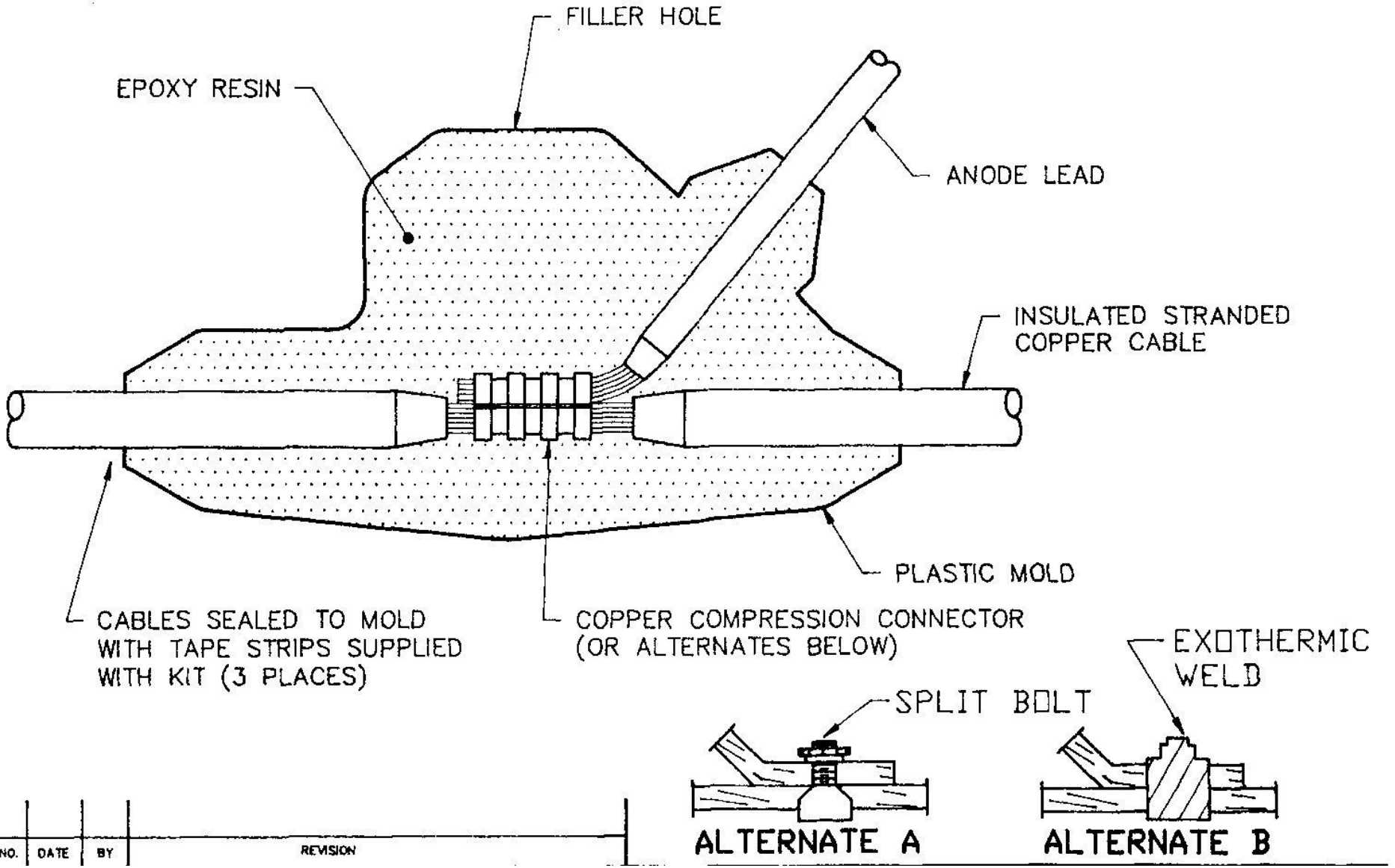

Bonding Strap
As a Metallic Connection
Pipe
Anodes
8mA + Read

Current Direction Indicated on Amp Clamp

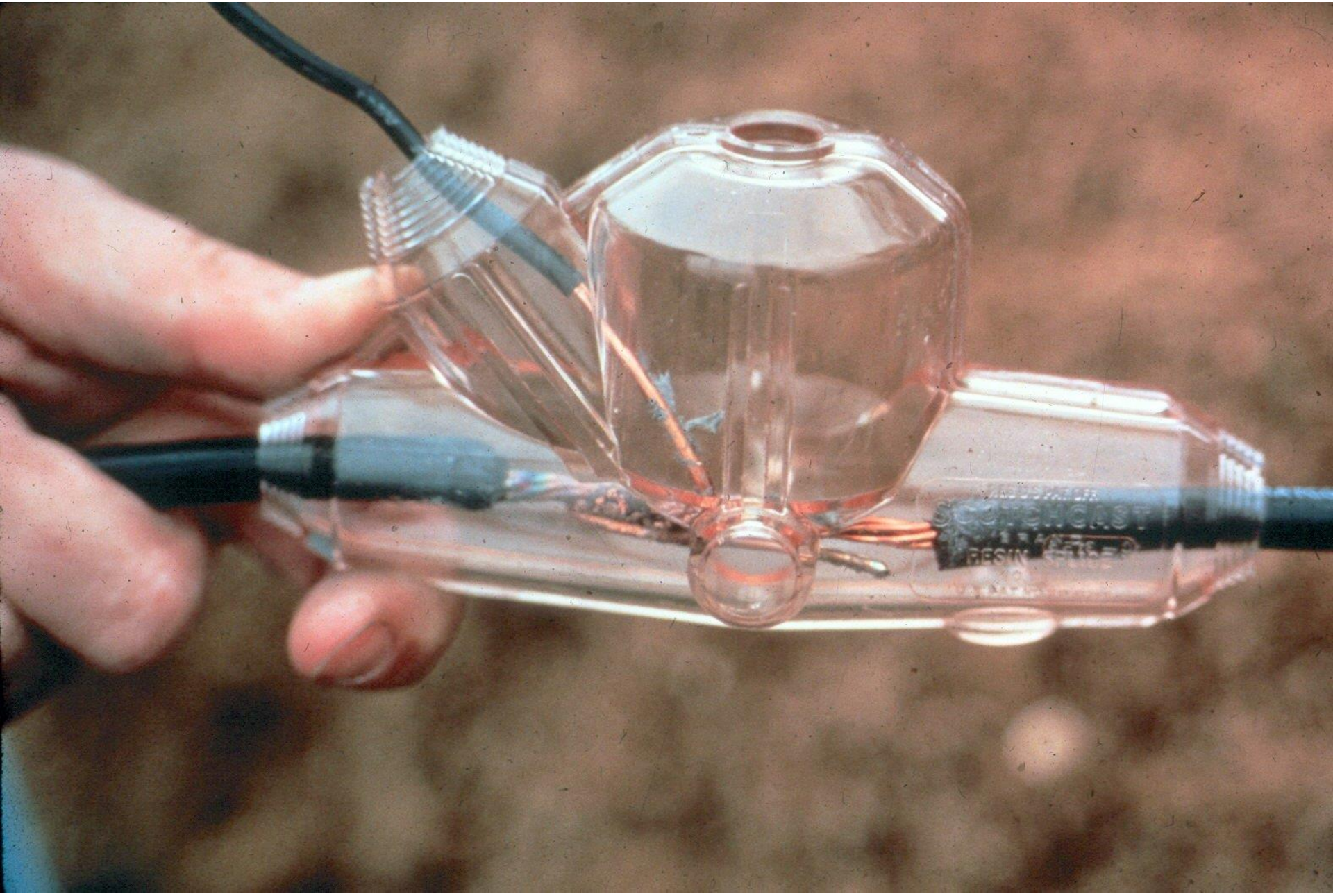


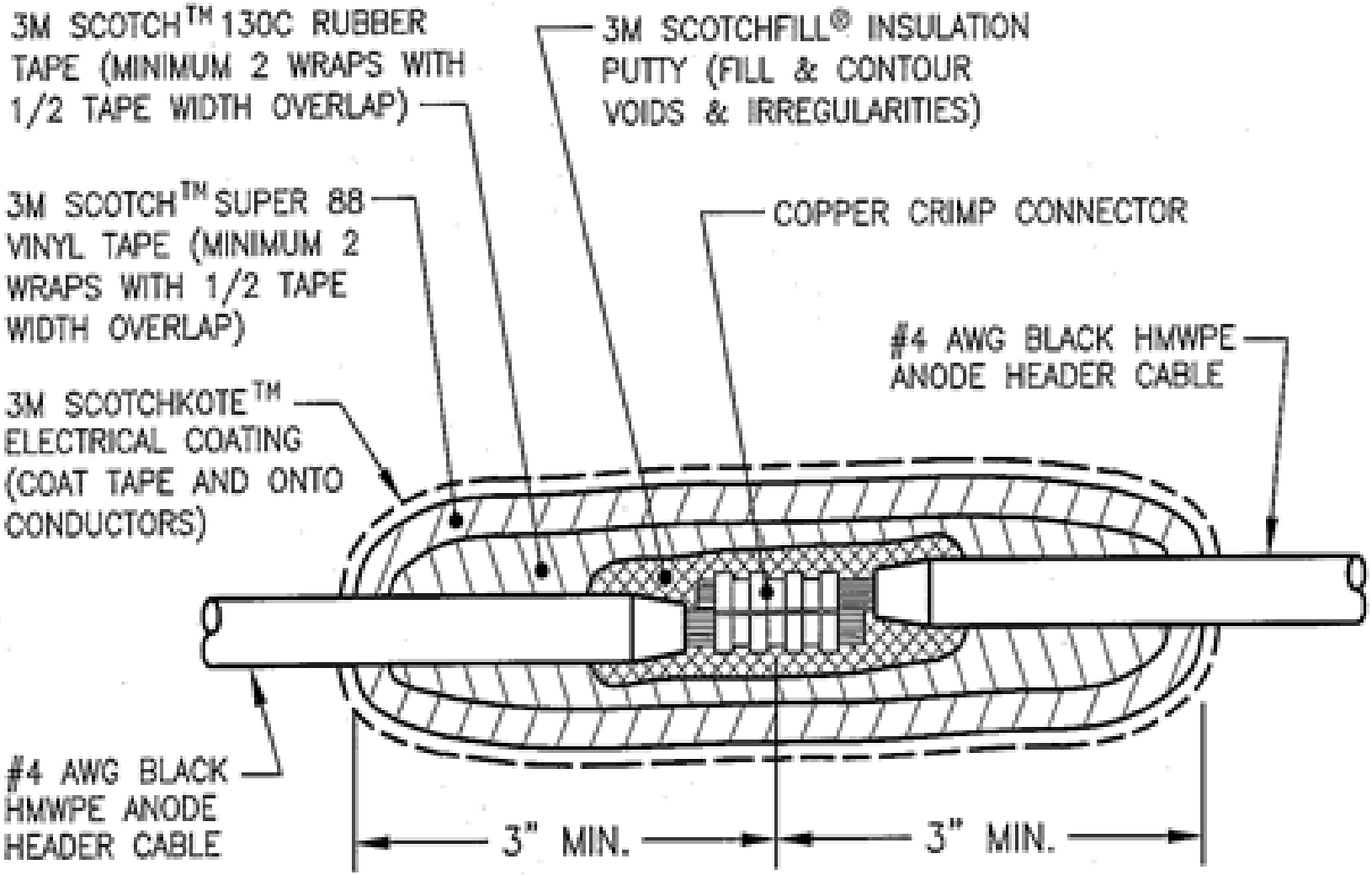
TYPICAL TEST POINT INSTALLATION

FIGURE 2-6

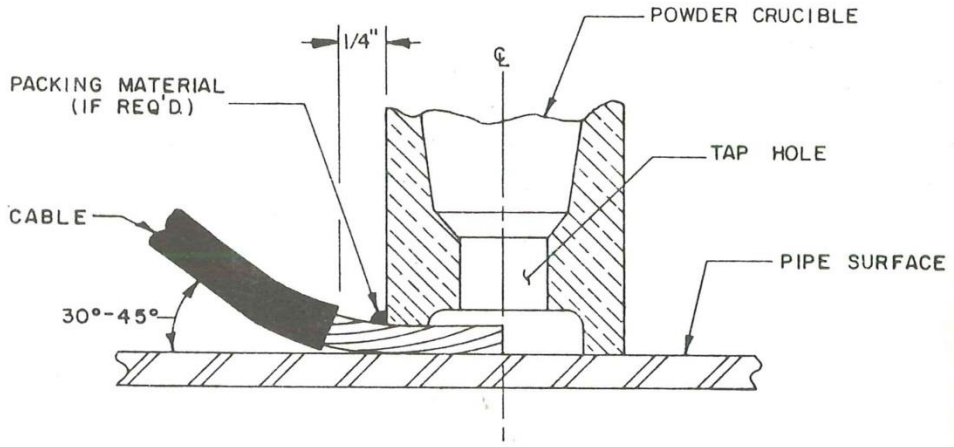


NO.	DATE	BY	REVISION



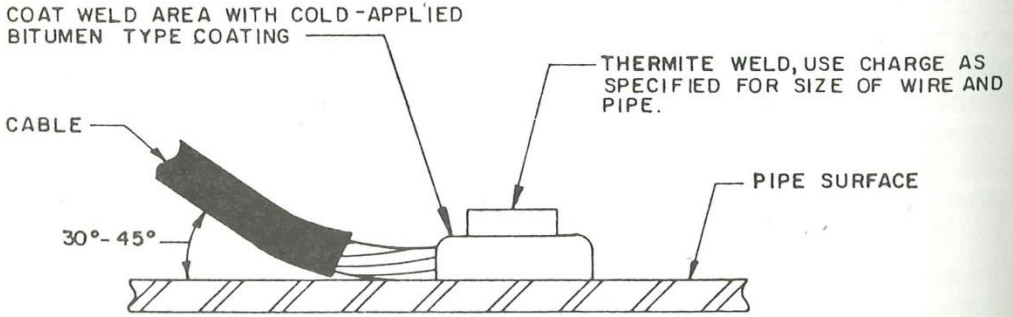


NOTE:
ALL SURFACES TO BE CLEAN, DRY AND FREE OF OIL, GREASE AND OTHER DEBRIS PRIOR TO INSTALLING SPLICE COATING MATERIALS..



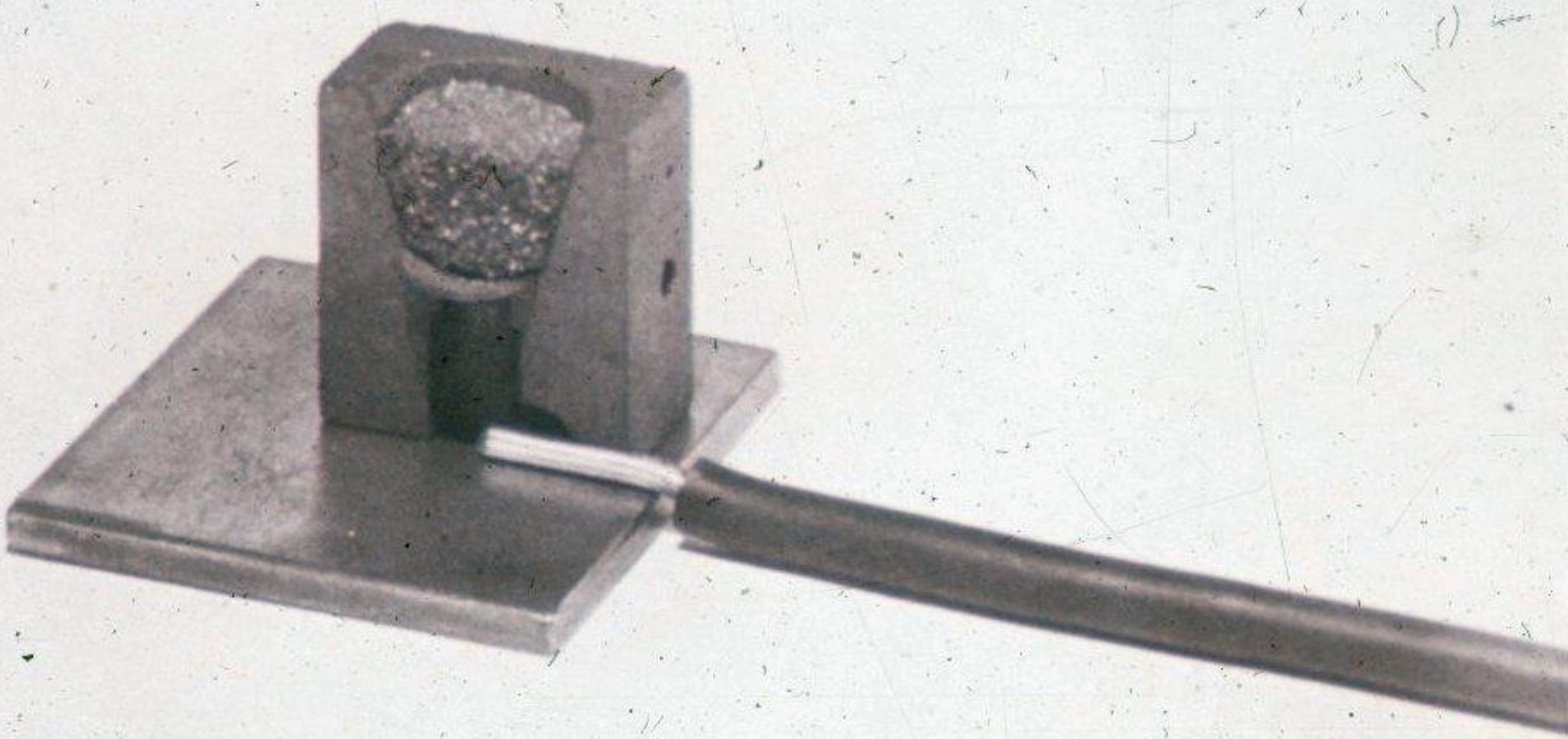
NOTE: END OF CABLE SHOULD NOT PASS CENTER LINE OF MOLD.

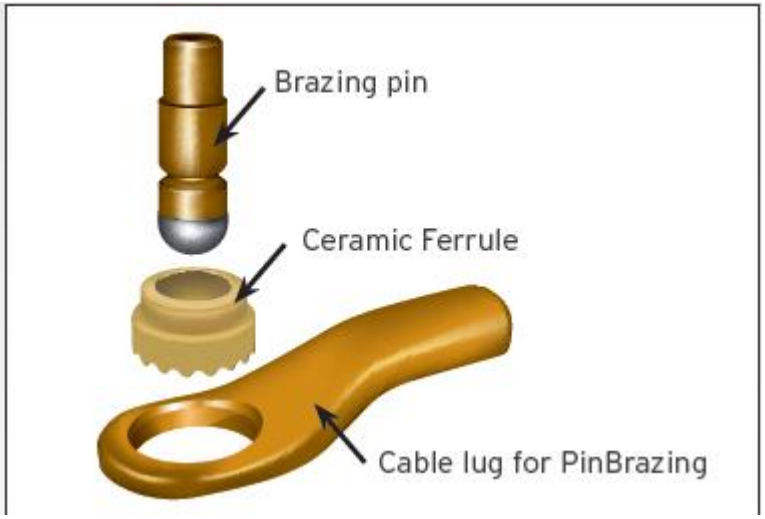
MOLD POSITIONING



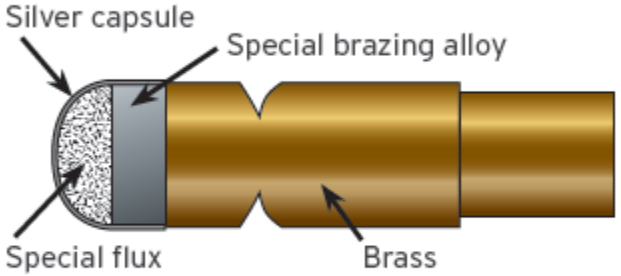
COMPLETED WELD

THERMITE WELD

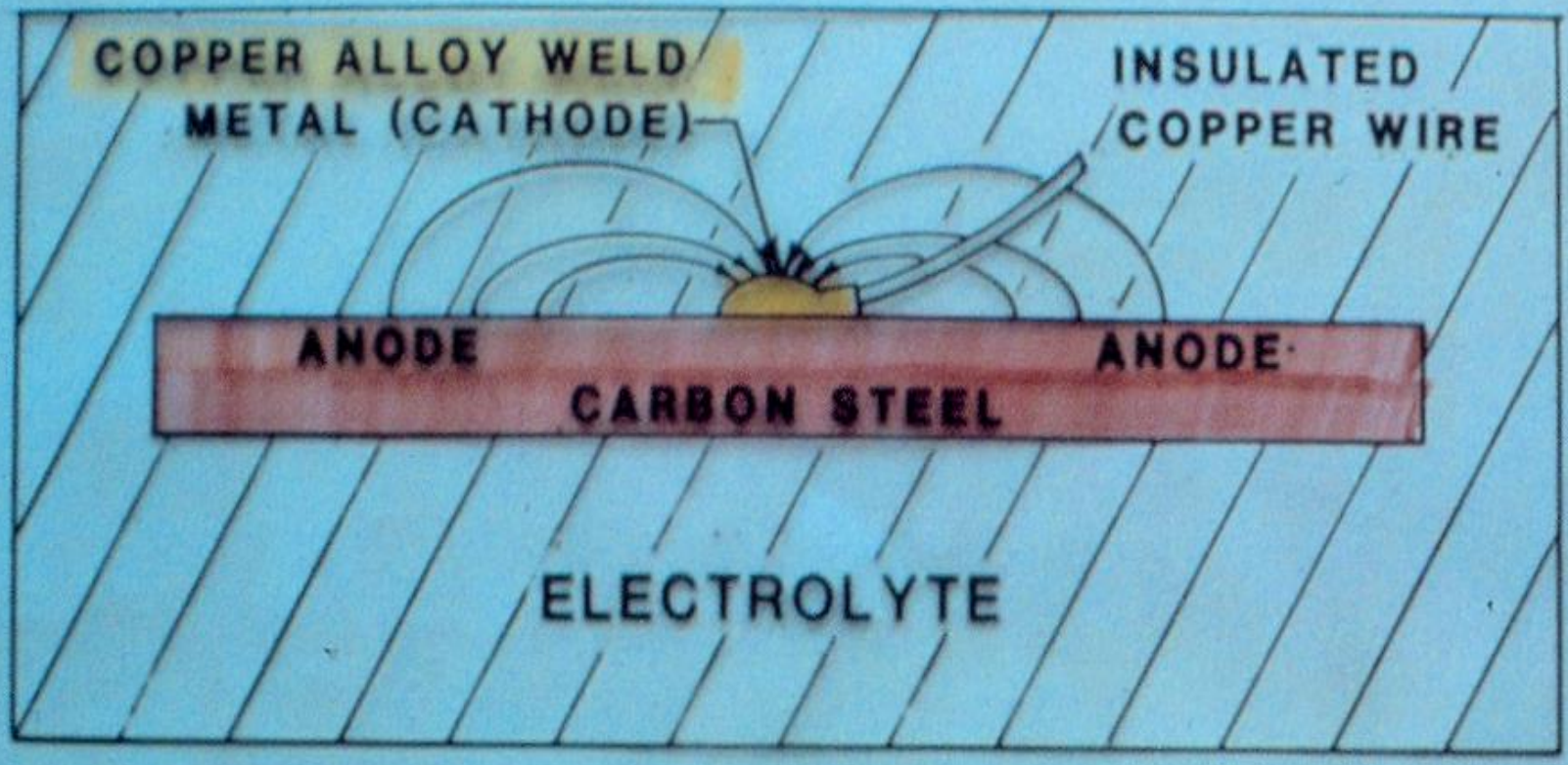




Brazing pin



Melting Temperature 1200°F / 650°C
Only 5 microohms/brazed joint

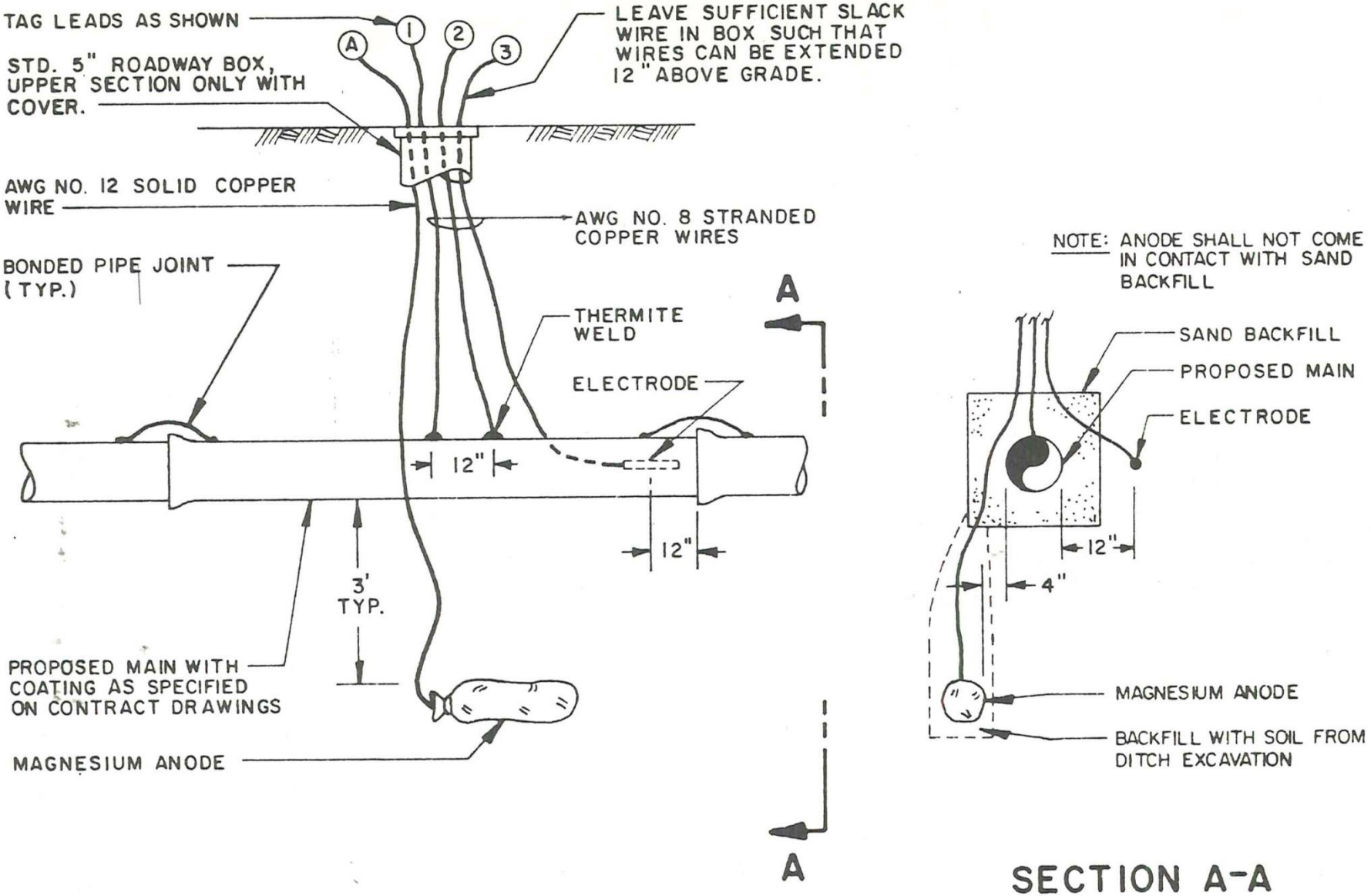


B. EXPOSED THERMIT WELD (COPPER) ON CARBON STEEL: LARGE ANODE VS SMALL CATHODE, SLOW CORROSION RATE

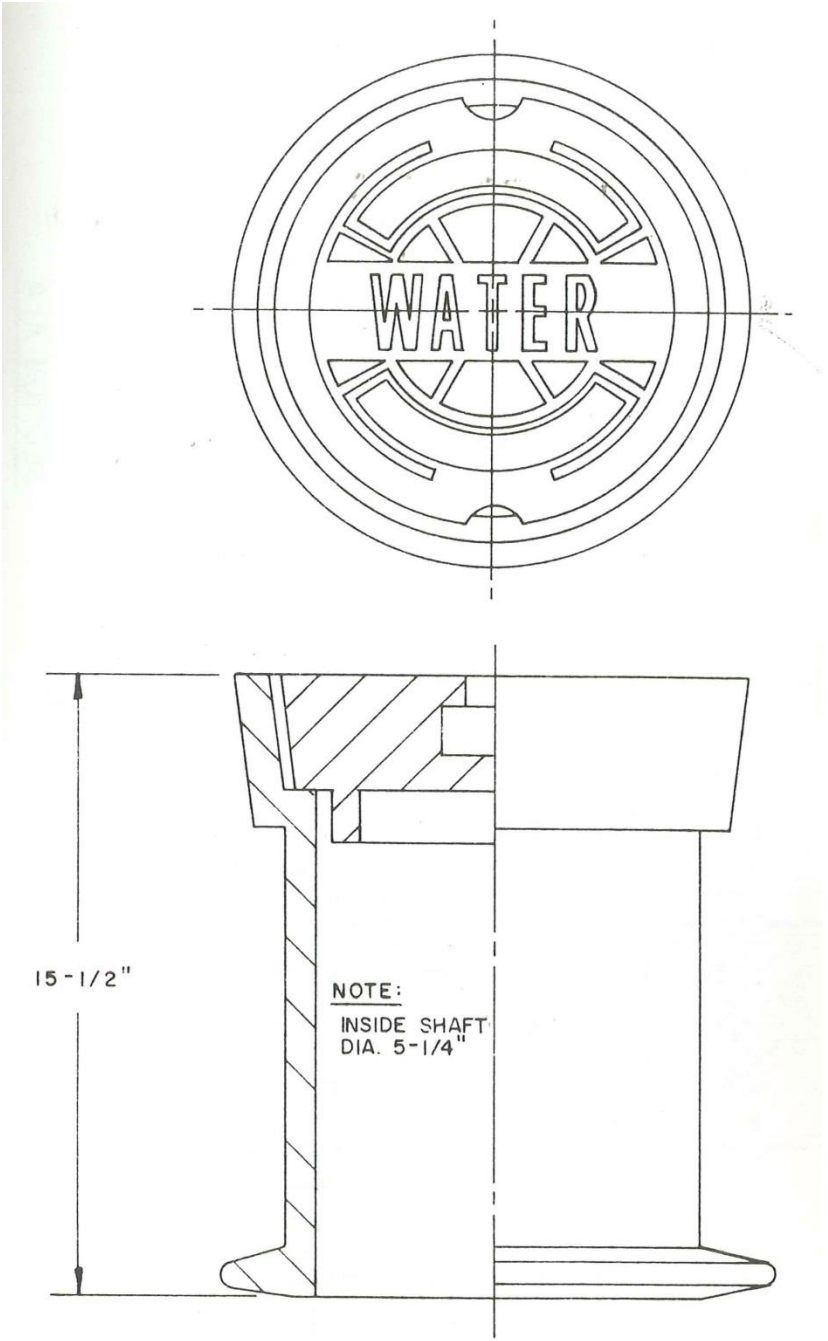
EFFECT OF RELATIVE AREA OF ANODE TO CATHODE


2009/06/25


PIPE
RE
NATIVE
COUPON
J1
At installation,
Keep switch in "off"
osition for 3 months min.
Date Installed: 6/30/08
2008/07/11

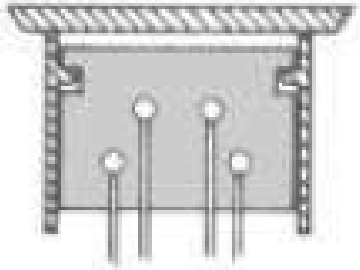


MAGNESIUM ANODE TEST STATION

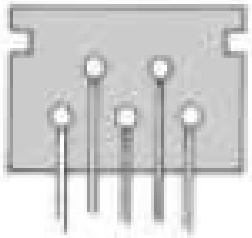


5" ROADWAY BOX

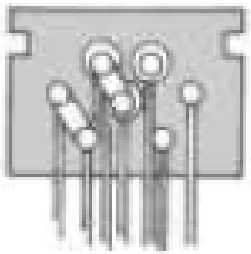
Plastic pipe, 5" I.D., 18" shaft length.



LID SECTION NM-4



NM-5



NM-7

Available with 4, 5 or 7 terminals.

Heavy cast iron lids, both locking and non-locking, available.

One-inch extensions available whenever road resurfacing occurs.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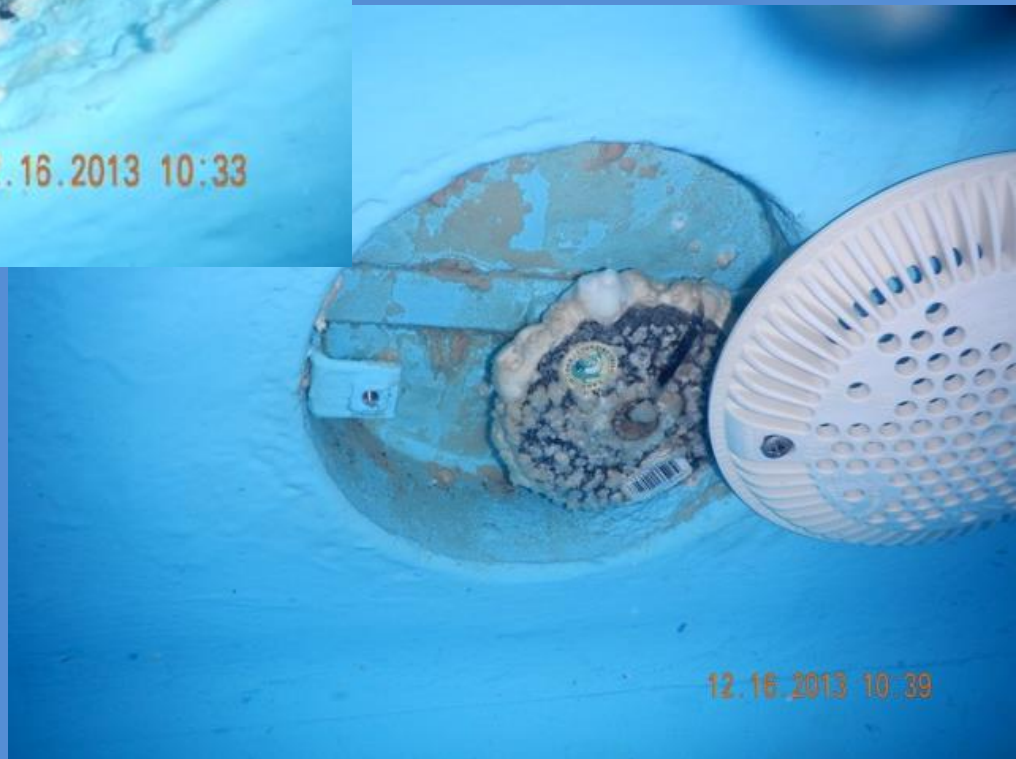
2009/06/24


2009/06/24


2009/06/24


2009/06/24


CADMIUM FREE - ANGLE
ENVIRO-FRIENDLY
12.16.2013 10:33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Now you know How!!

ANY QUESTIONS??