SIEO Water Box Demonstration/BSU

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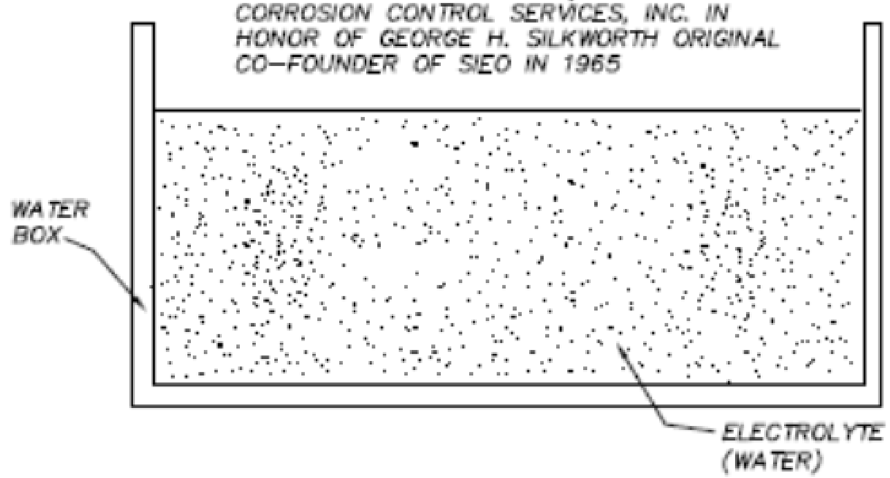
SOUTHERN IDAHO EASTERN OREGON (SIEO) UNDERGROUND CORROSION COMMITTEE AND INTERMOUNTAIN SECTION OF NATIONAL ASSOCIATION OF CORROSION ENGINEERS INTERNATIONAL (NACE) DONATED WATERBOX CORROSION DEMONSTRATION 2015

ASSEMBLED BY ROGER HENRIE/WILLIAMS GAS COMPANY, BRANDON CROY/INTERMOUNTAIN GAS and BILL SPICKELMIRE/RUSTNOT CORROSION CONTROL SERVICES, INC. IN HONOR OF GEORGE H. SILKWORTH ORIGINAL CO–FOUNDER OF SIEO IN 1965



DEMONSTRATION: Corrosion principles and test measurements in a waterbox with a water electrolyte is shown to reflect buried soil conditions and pipeline related corrosion issues and protection methods.

QUESTIONS

1a. Typical questions are asked for each demonstration to reinforce the demonstration's examples and basic principals shown.

WATER BOX CORROSION DEMONSTRATION

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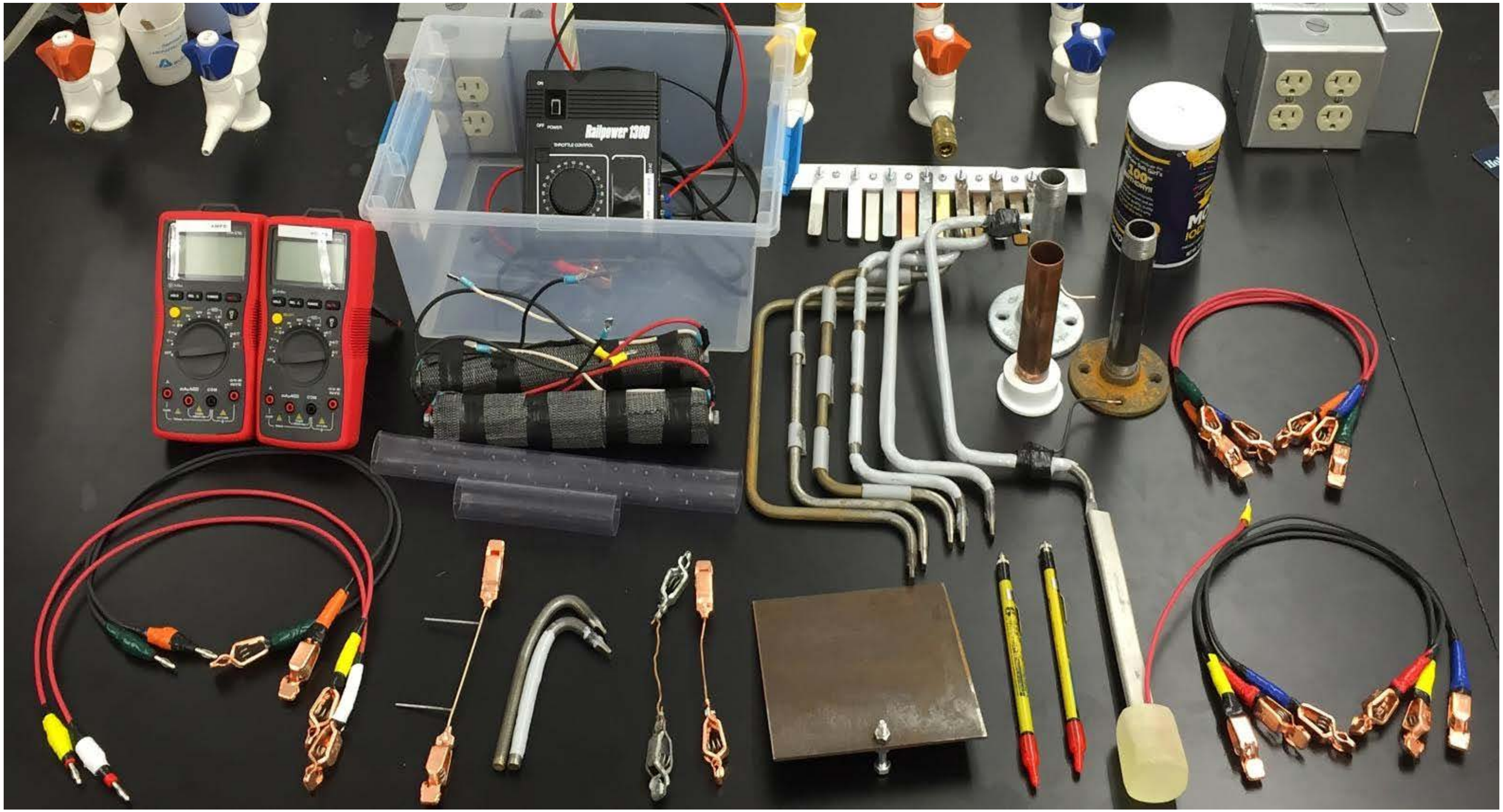
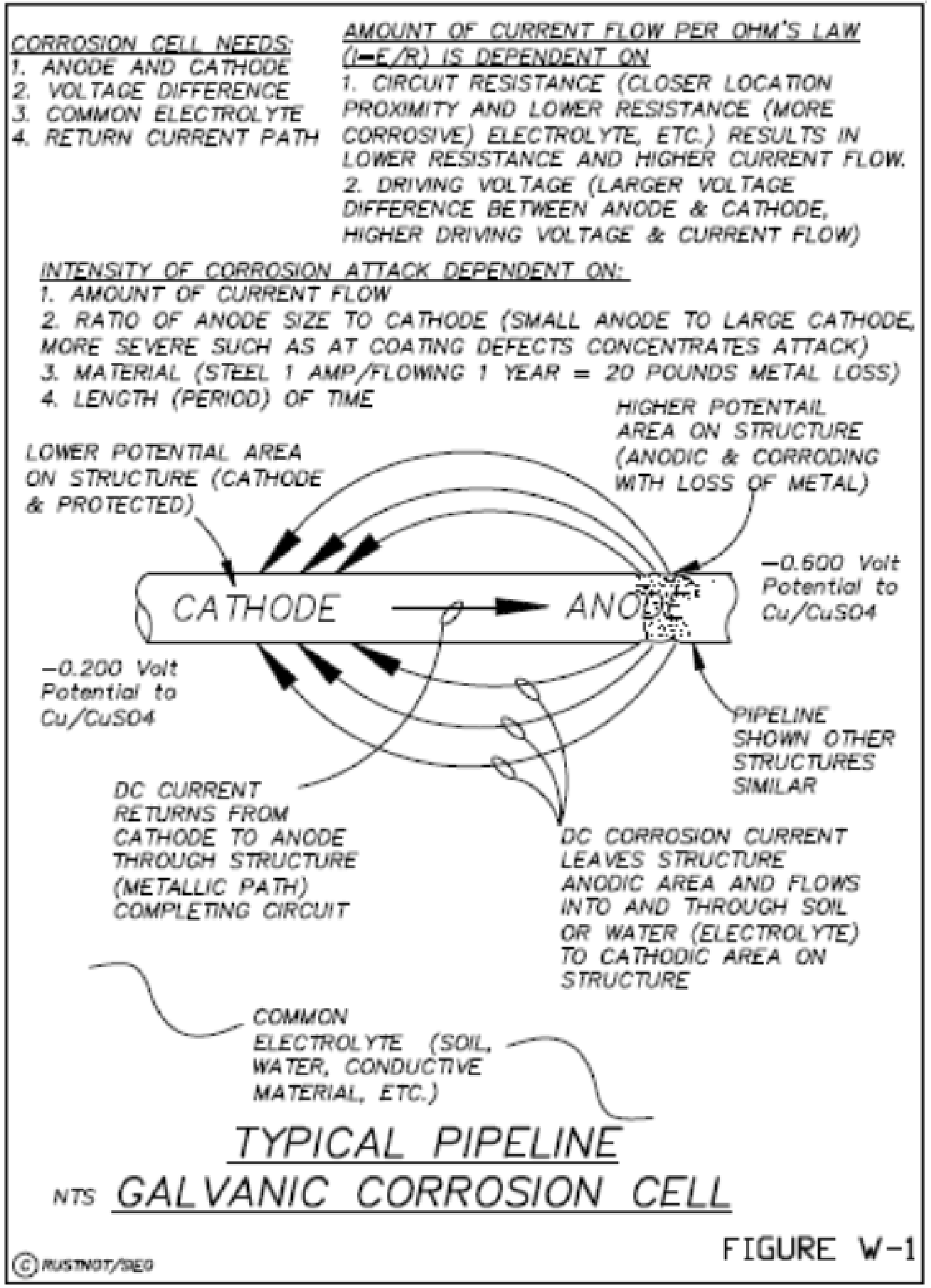
DETAIL W–SIEO

W-0 Water Box Materials




CORROSION CELL NEEDS:
1. ANODE AND CATHODE
2. VOLTAGE DIFFERENCE
3. COMMON ELECTROLYTE
4. RETURN CURRENT PATH
AMOUNT OF CURRENT FLOW PER OHM'S LAW (I=E/R) IS DEPENDENT ON
1. CIRCUIT RESISTANCE (CLOSER LOCATION PROXIMITY AND LOWER RESISTANCE (MORE CORROSIVE) ELECTROLYTE, ETC.) RESULTS IN LOWER RESISTANCE AND HIGHER CURRENT FLOW.
2. DRIVING VOLTAGE (LARGER VOLTAGE DIFFERENCE BETWEEN ANODE & CATHODE, HIGHER DRIVING VOLTAGE & CURRENT FLOW)
INTENSITY OF CORROSION ATTACK DEPENDENT ON:
1. AMOUNT OF CURRENT FLOW
2. RATIO OF ANODE SIZE TO CATHODE (SMALL ANODE TO LARGE CATHODE, MORE SEVERE SUCH AS AT COATING DEFECTS CONCENTRATES ATTACK)
3. MATERIAL (STEEL 1 AMP/FLOWING 1 YEAR = 20 POUNDS METAL LOSS)
4. LENGTH (PERIOD) OF TIME
HIGHER POTENTAIL AREA ON STRUCTURE (ANODIC & CORRODING WITH LOSS OF METAL)
LOWER POTENTIAL AREA ON STRUCTURE (CATHODE & PROTECTED)
CATHODE
ANODE
−0.600 Volt Potential to Cu/CuSO4
−0.200 Volt Potential to Cu/CuSO4
PIPELINE SHOWN OTHER STRUCTURES SIMILAR
DC CURRENT RETURNS FROM CATHODE TO ANODE THROUGH STRUCTURE (METALLIC PATH) COMPLETING CIRCUIT
DC CORROSION CURRENT LEAVES STRUCTURE ANODIC AREA AND FLOWS INTO AND THROUGH SOIL OR WATER (ELECTROLYTE) TO CATHODIC AREA ON STRUCTURE
COMMON ELECTROLYTE (SOIL, WATER, CONDUCTIVE MATERIAL, ETC.)
TYPICAL PIPELINE
NTS GALVANIC CORROSION CELL
FIGURE W-1
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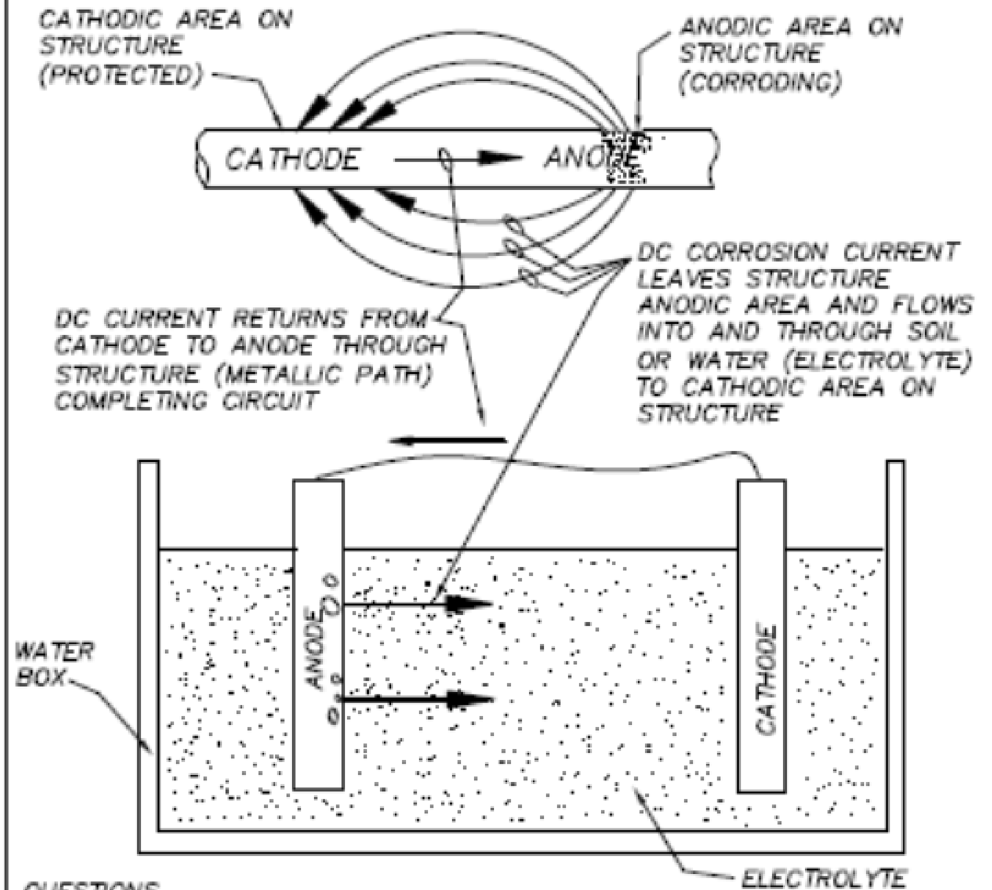
DEMONSTRATION: A typical corrosion cell and the items necessary for it's formation is shown.



QUESTIONS

1a. What are the four factors necessary for a corrosion cell to occur?

1b. What occurs at the anode? At the cathode?

1c. What are some different types of electrolytes?

1d. What influence does the ratio of the anode size to cathode size have?

WATER BOX CORROSION CELL

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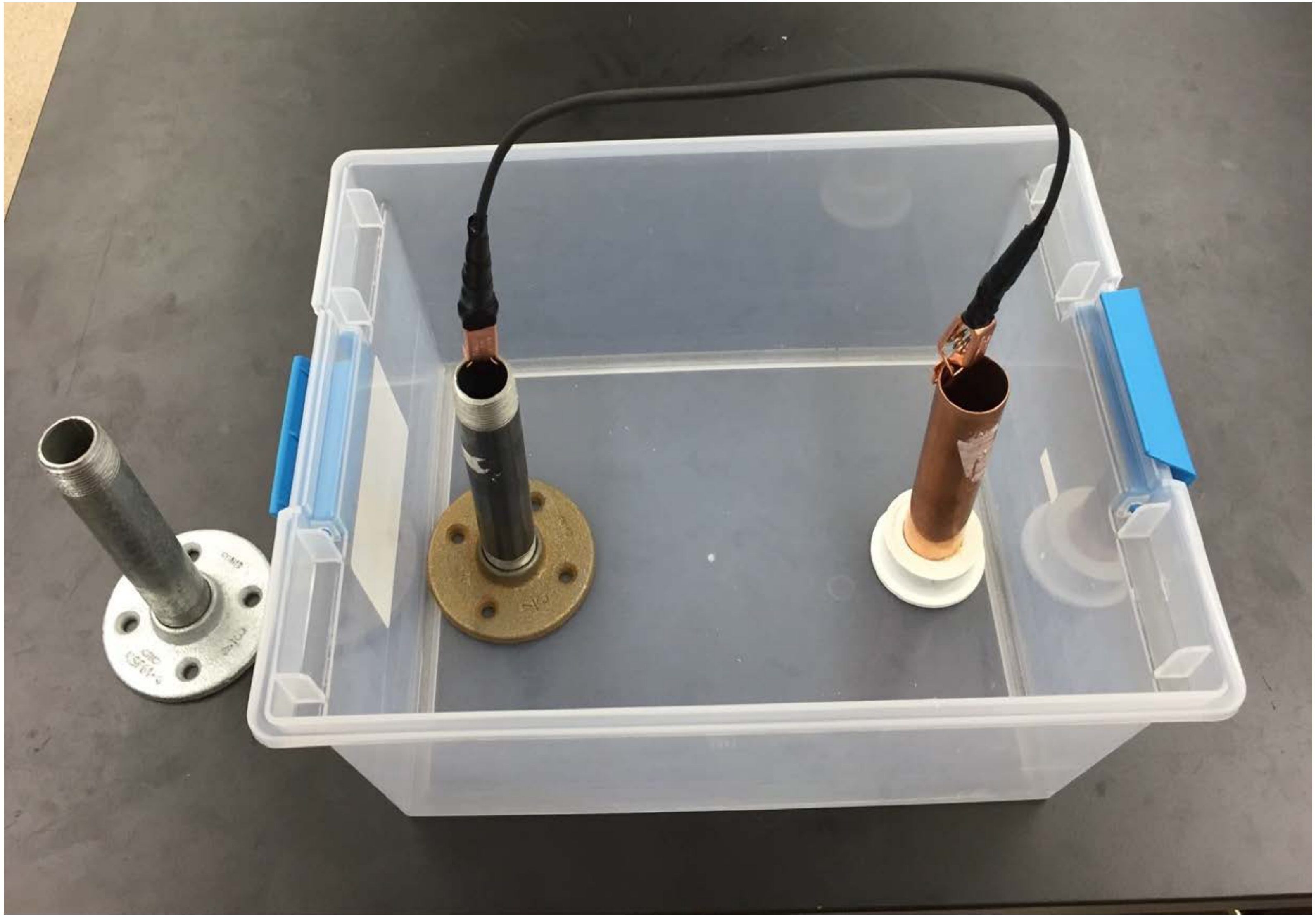
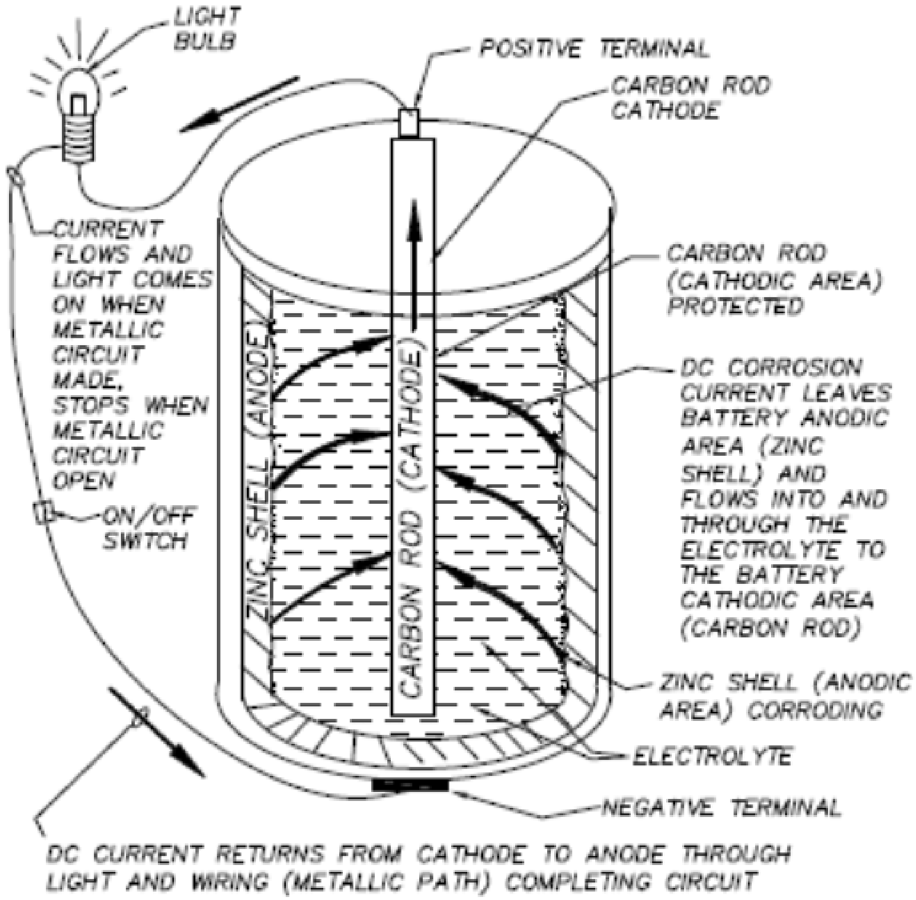
DETAIL W-1A

W-1A Corrosion Cell



DEMONSTRATION: A typical battery and how it is a simple galvnic corrosion cell and the materials for it's formation is shown.



QUESTIONS

1Aa. How is the battery like a galvanic corrosion cell?

1Ab. What occurs at the anode? At the cathode?

1Ac. How is the battery (corrosion cell) activated?

TYPICAL BATTERY CORROSION CELL

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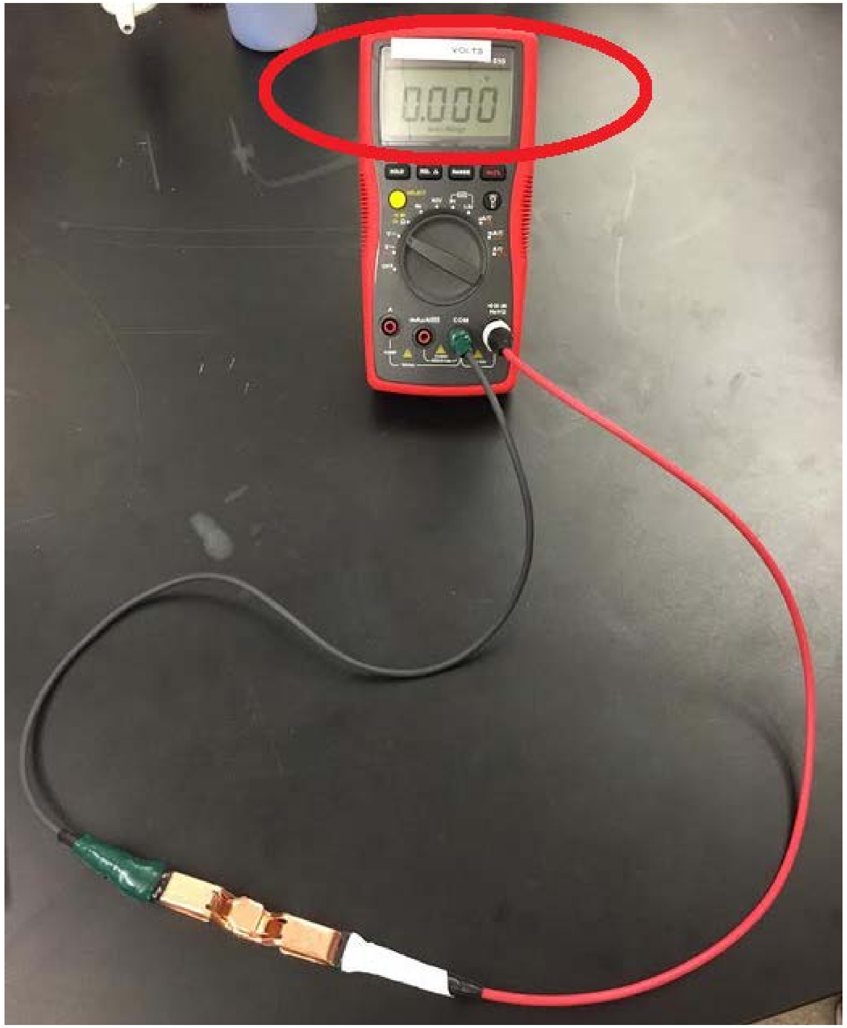
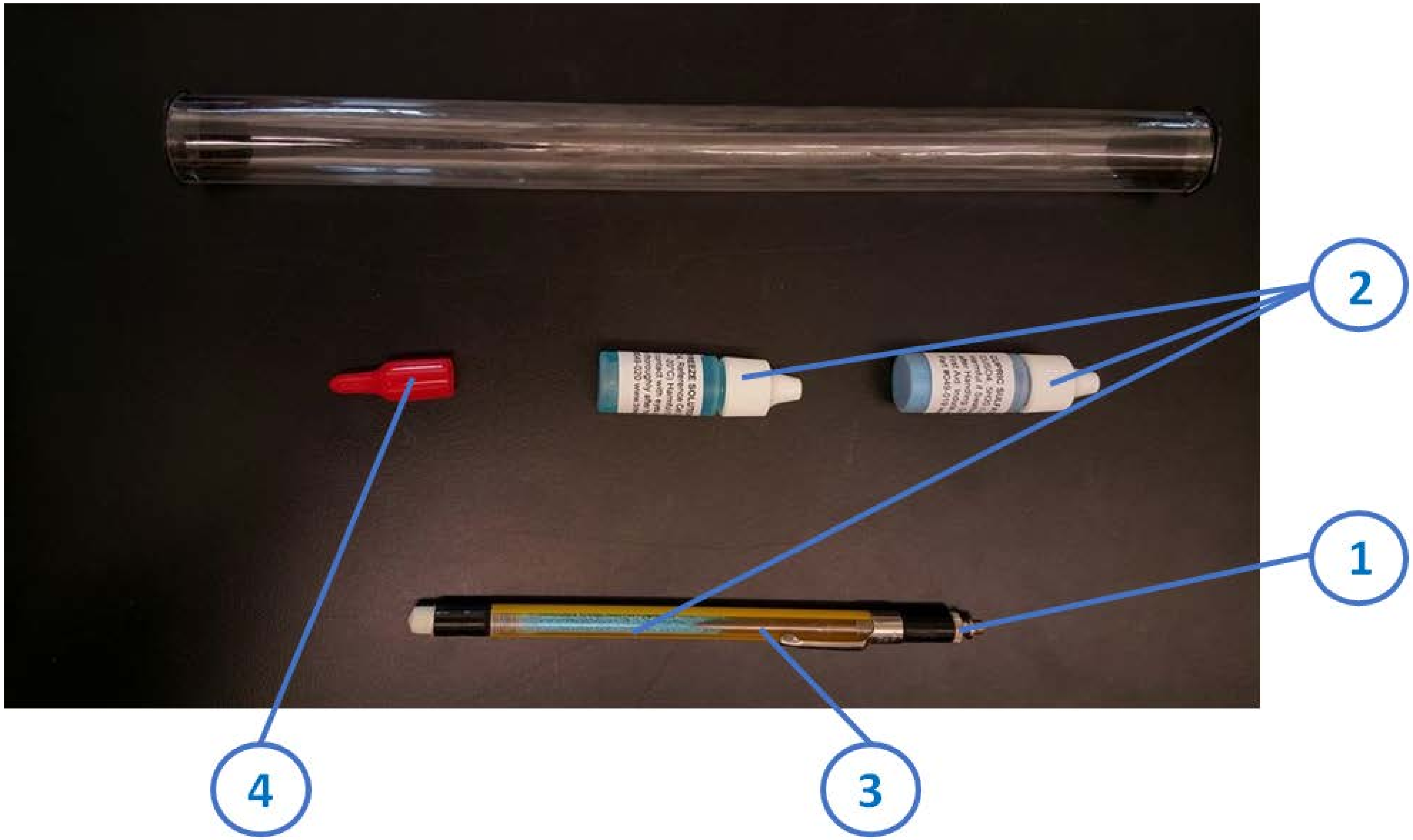
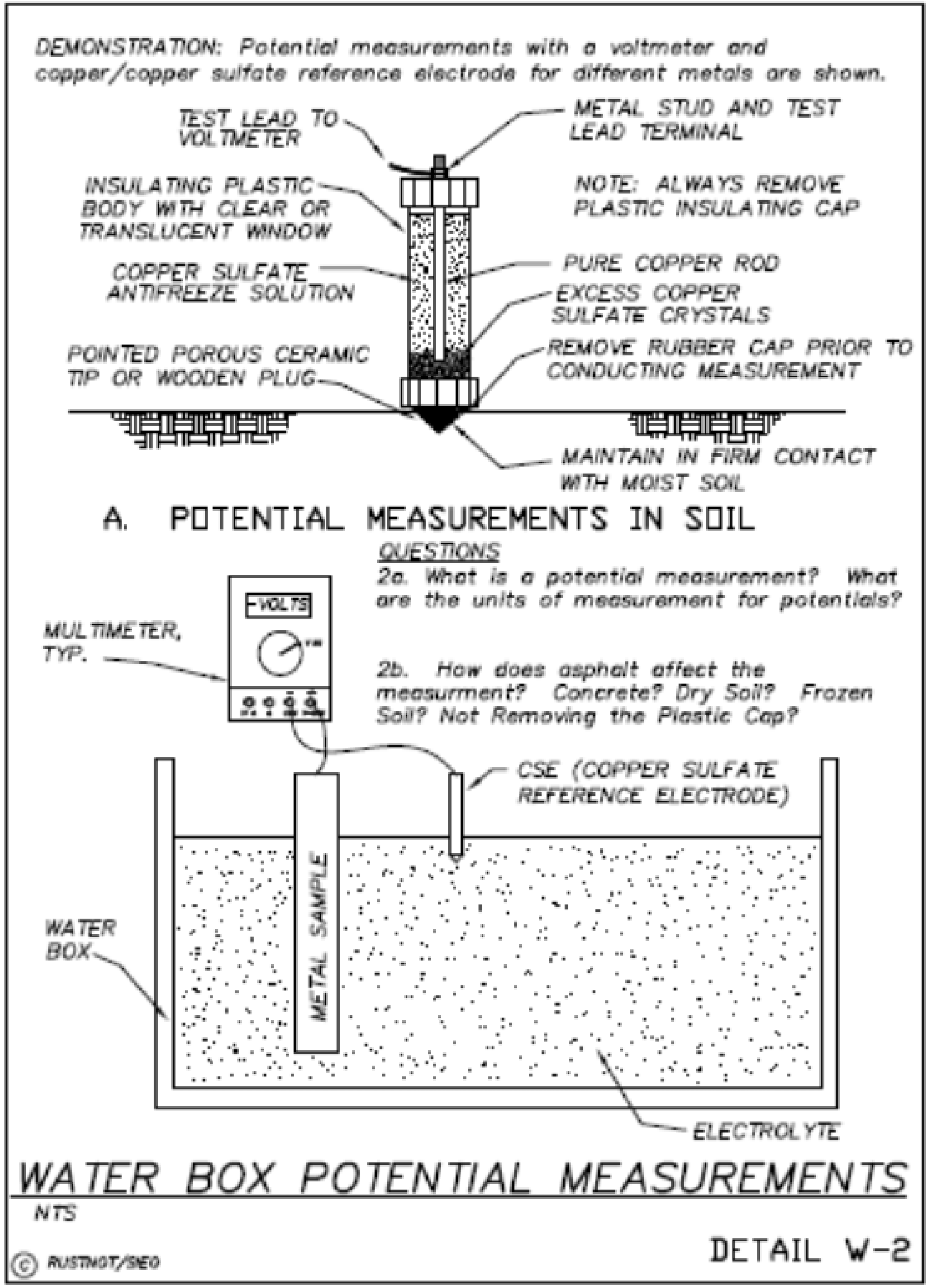
DETAIL W-1B

Multimeter



Reference Electrodes





DEMONSTRATION: Potential measurements with a voltmeter and copper/copper sulfate reference electrode for different metals are shown.
TEST LEAD TO VOLTMETER
METAL STUD AND TEST LEAD TERMINAL
INSULATING PLASTIC BODY WITH CLEAR OR TRANSLUCENT WINDOW
NOTE: ALWAYS REMOVE PLASTIC INSULATING CAP
COPPER SULFATE ANTIFREEZE SOLUTION
PURE COPPER ROD
EXCESS COPPER SULFATE CRYSTALS
POINTED POROUS CERAMIC TIP OR WOODEN PLUG
REMOVE RUBBER CAP PRIOR TO CONDUCTING MEASUREMENT
MAINTAIN IN FIRM CONTACT WITH MOIST SOIL
A. POTENTIAL MEASUREMENTS IN SOIL
QUESTIONS
2a. What is a potential measurement? What are the units of measurement for potentials?
2b. How does asphalt affect the measurment? Concrete? Dry Soil? Frozen Soil? Not Removing the Plastic Cap?
MULTIMETER, TYP.
VOLTS
CSE (COPPER SULFATE REFERENCE ELECTRODE)
METAL SAMPLE
WATER BOX
ELECTROLYTE
WATER BOX POTENTIAL MEASUREMENTS
NTS
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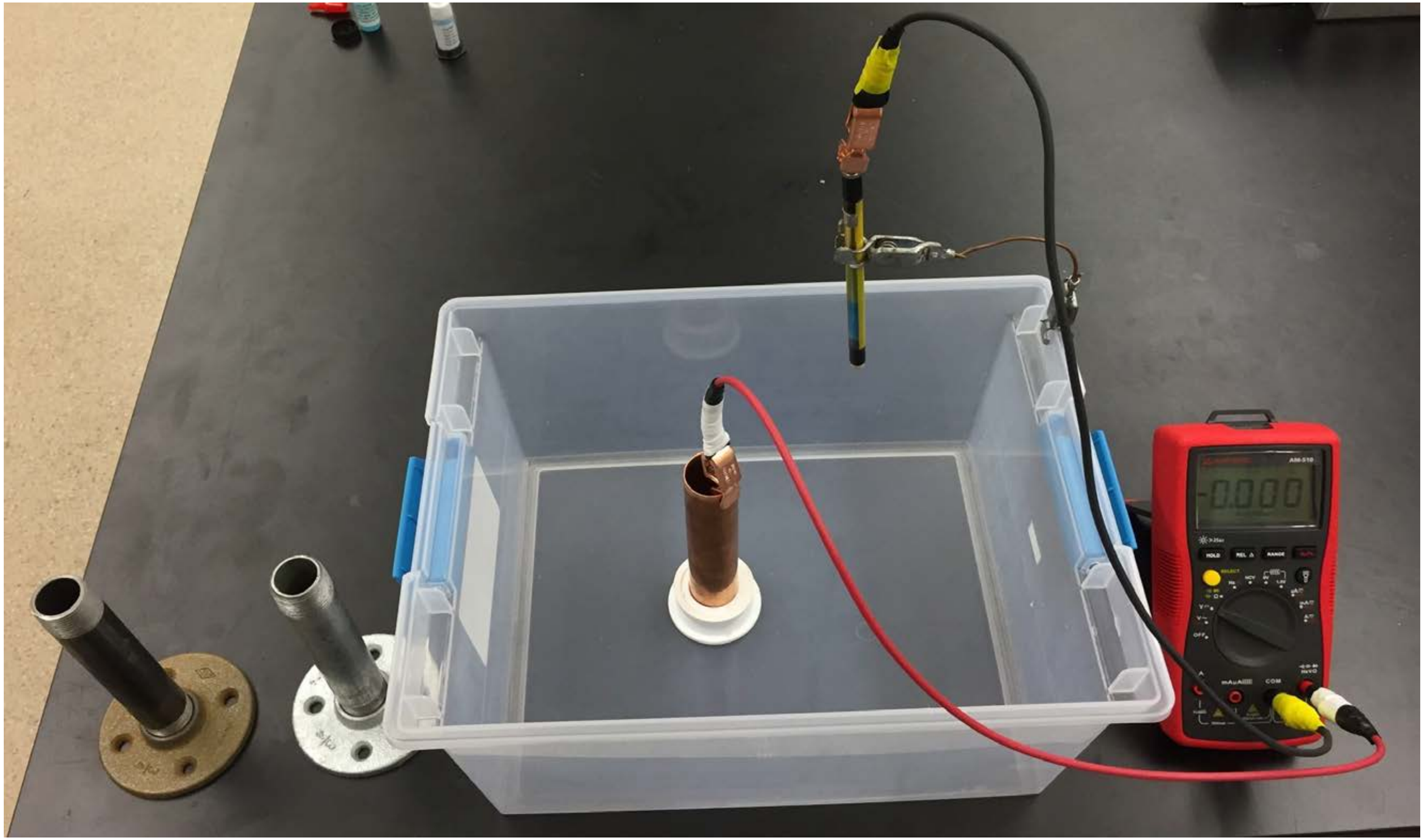
DETAIL W-2

W-2 Water Box Potential Measurements



DEMONSTRATION: A practical galvanic series with differnt metals is shown.

No., METAL (ID No.)	POTENTIAL VOLTS vs. CSE
1. Magnesium (Mag AZ31B)	______
2. Zinc (ZN)	______
3. Aluminum (AL1100)	______
4. Galvanized Steel (GALV)	______
5. New Steel (bright) (C1010)	______
6. Old Steel (rusty) (C1010)	______
7. Concrete Encased Steel (C1010)	______
8. Gray Cast Iron (GCCL30)	______
9. Ductile Iron (DUCTILE 65–45–12)	______
10. Brass (CDA443)	______
11. Copper (CDA110)	______
12. Stainless Steel (316L)	______
13. Graphite (Rigid Carbon Fiber)	______

QUESTIONS

3a. Which end of the galvanic series is anodic? Which end is cathodic?

3b. How can the location of two metals on the galvanic series be used?

3c. What influence does the seperation distance on the gavanic series chart between two metals have?

3d. Does the quality of surface area of a metal in electrolyte affect its potential, and why?

3e. Does the quantity of the surface area of a metal in the electrolyte affect its potential, and why?

3f. How can potential measurements be used to predict which metals will corrode? Can potentials be used to predict actual severity of corrosion?

PRACTICAL GALVANIC SERIES

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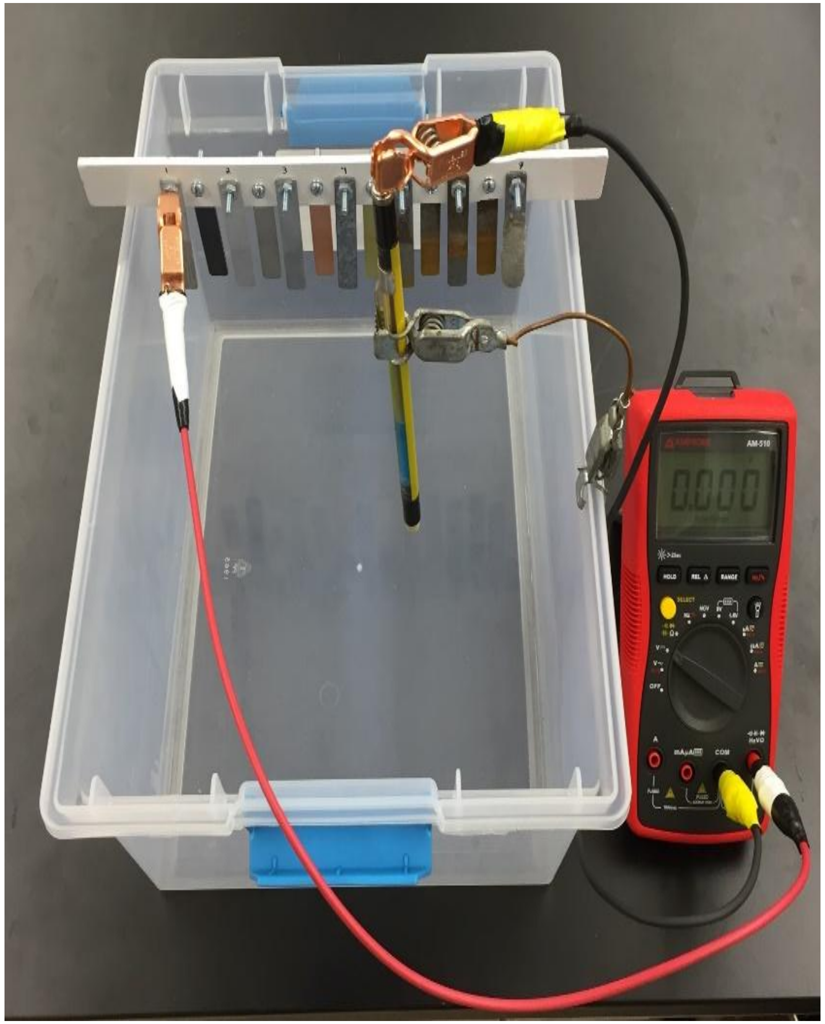
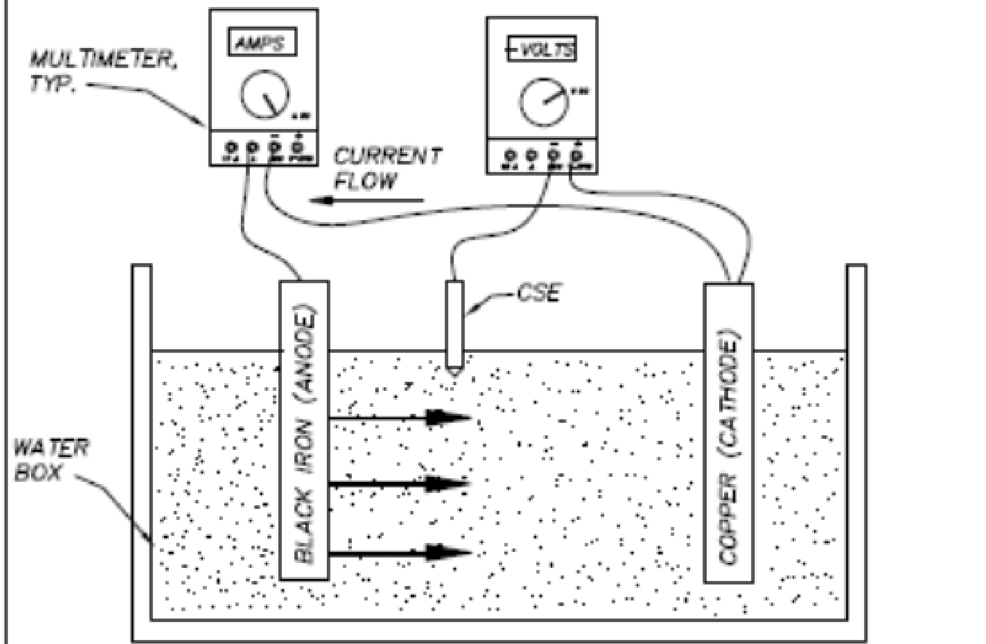
DETAIL W-3

W-3 Practical Galvanic Series



DEMONSTRATION: Current flow is measured in a metallic conductor and the change in potential on both metals in a galvanic corrosion cell is shown.



OHMS LAW $E = IR$ or $I = \frac{E}{R}$ WHERE: I = Current, E = Voltage, R = Resistance

If Small Driving Voltage and/or High Resistance = Less Corrosive
If Large Driving Voltage and/or Low Resistance = More Corrosive

1 amp of current flowing for 1 year = 20 pound iron metal loss

QUESTIONS

4a. How does the electrolyte resistivity affect the corrosion rate?

4b. What would the potential difference between graphite and new steel be? What would the potential difference be between copper and new steel? Which material will be the anode?

4c. What would be the amount (pounds) of steel metal loss if 250 milli-amps of current flowed for a year?

TYPICAL GALVANIC CORROSION CELL

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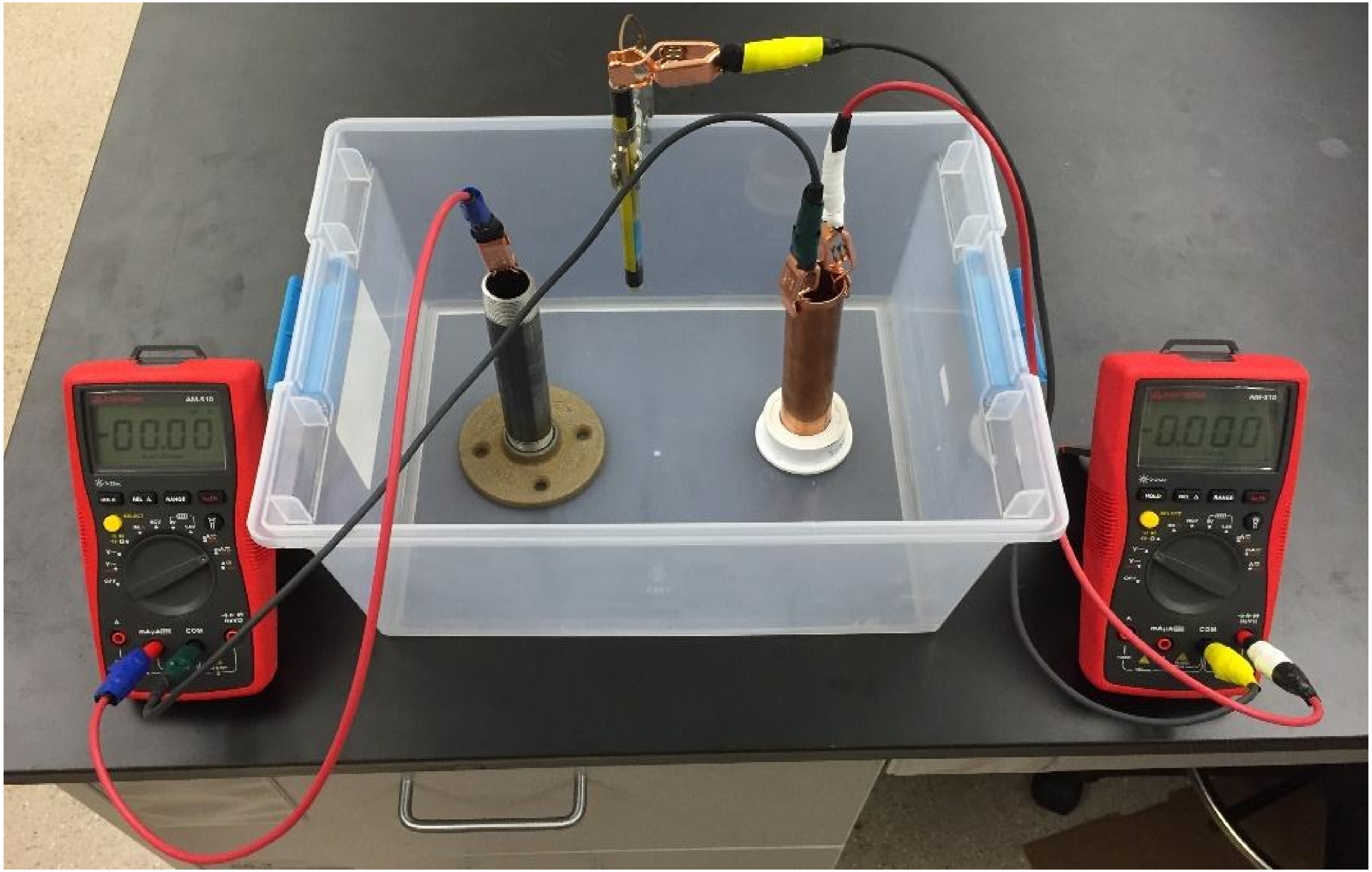
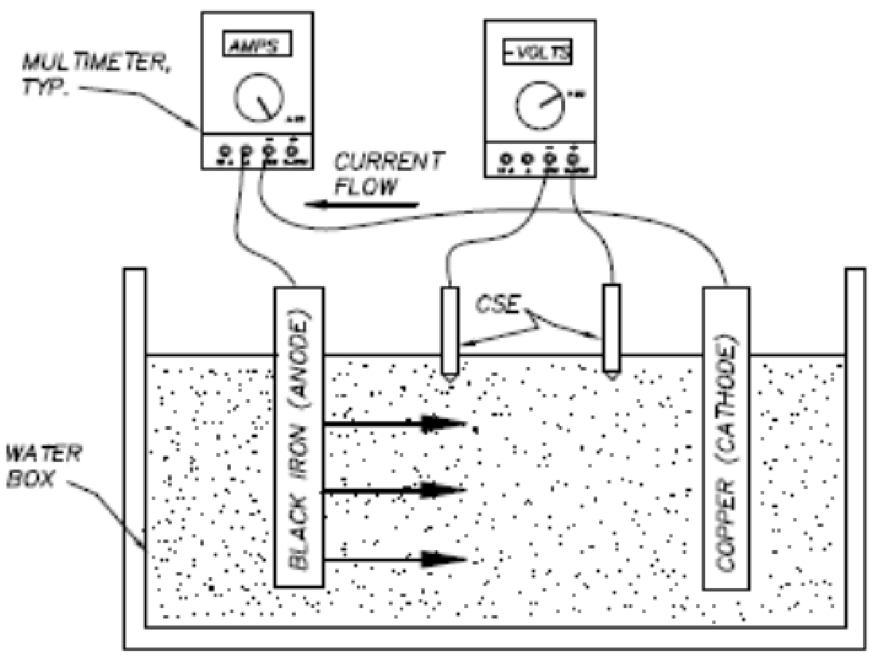
DETAIL W-4

W-4 and W-4A Galvanic Corrosion Cell



DEMONSTRATION: Current is measured in a metallic conductor and in the electrolyte, and the effect of current through the electrolyte is shown.



QUESTIONS

4a. Why does current flow occur between dissimilar metals in an electrolyte?

4b. What factors determine the magnitude of the current flow between dissimilar metals in an electrolyte?

4c. What is the direction of the current flow in the electrolyte? In the metallic portion of the circuit?

4d. What is IR?
What are the units of measurement of IR?

WATER BOX CURRENT AND IR

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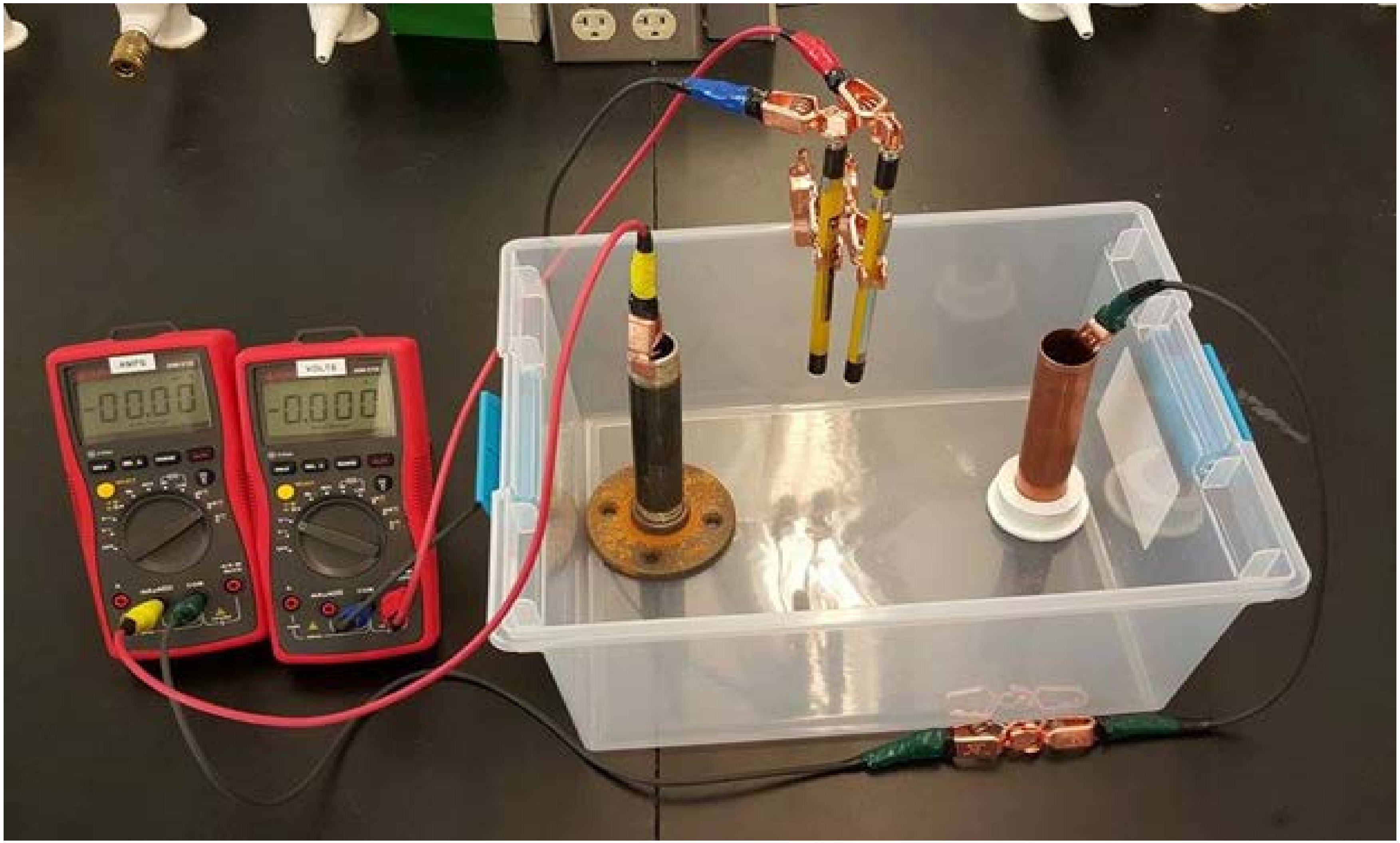
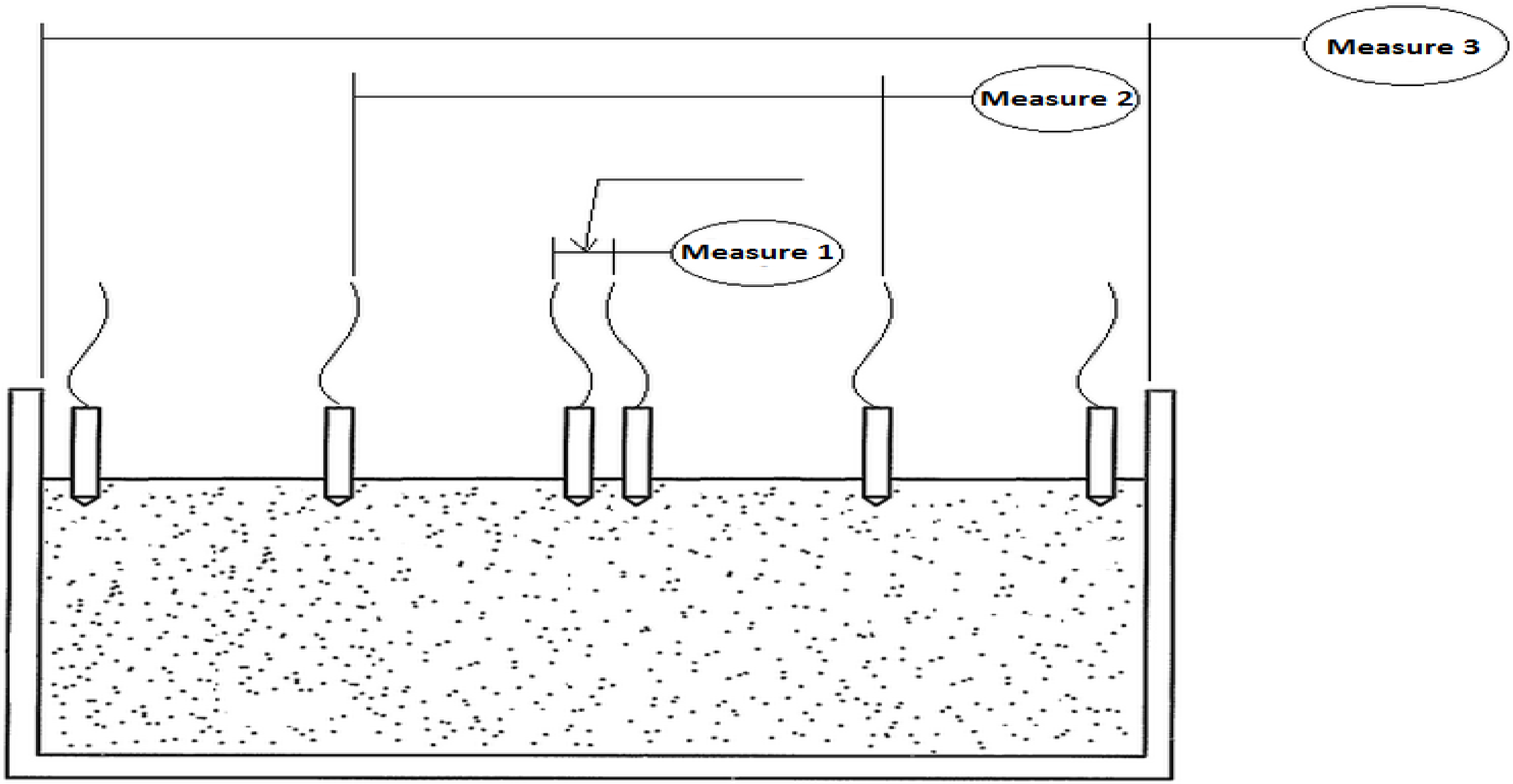
DETAIL W-4A

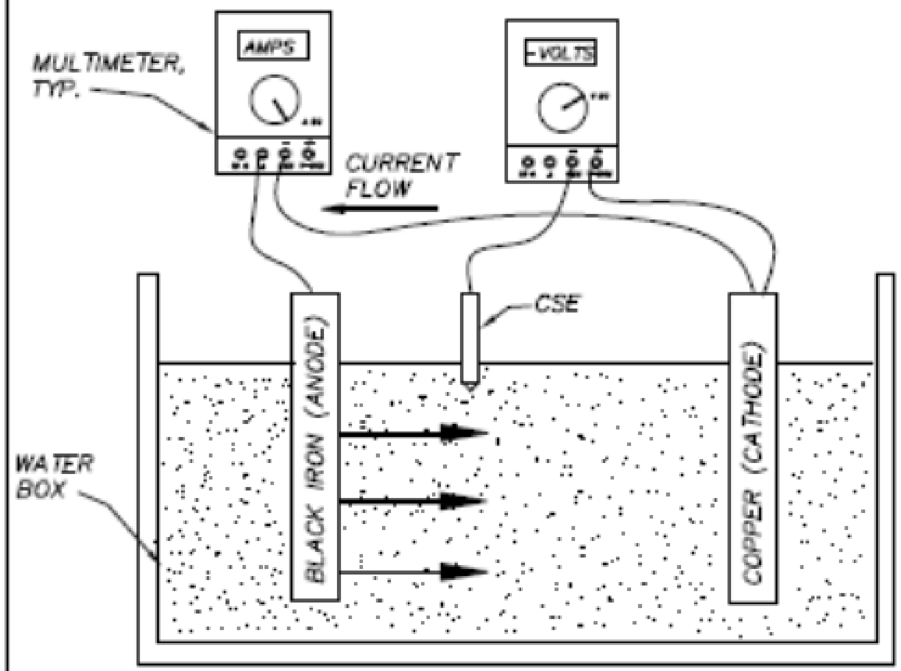
W-5 Current Flow and IR



W-5A IR Drop Increase with Distance



DEMONSTRATION: Corrosion control methods and their influence on current flow in a galvanic corrosion cell is shown.



TYPICAL CORROSION CONTROL METHODS

Materials Selection
Change Environment
Electrical Isolation
Coatings
Cathodic Protection

QUESTIONS

5a. For a pipeline which is the primary corrosion control method? Secondary method?

5b. How can material selection be used to minimize galvanic corrosion?

5c. For a buried pipeline how would one change the environment?

5d. How for a pipeline would one provide electrical isolation to minimize corrosion cells?

CORROSION CONTROL METHODS

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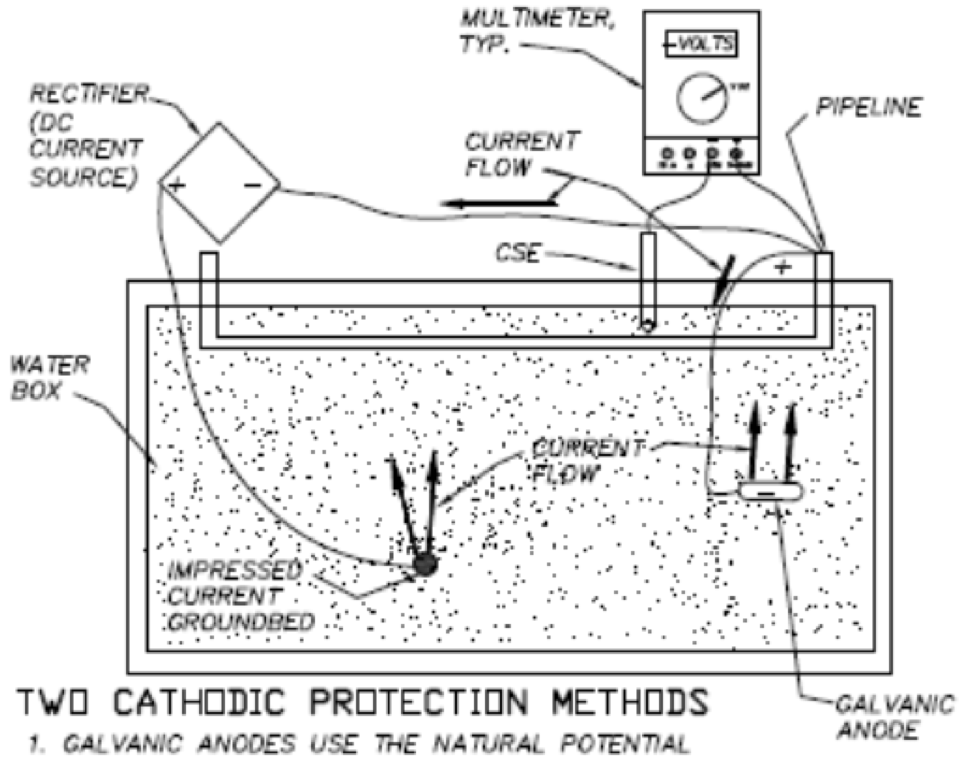
DETAIL W-5

DEMONSTRATION: The two types of cathodic protection systems are discussed.



TWO CATHODIC PROTECTION METHODS

1. GALVANIC ANODES USE THE NATURAL POTENTIAL DIFFERENCE AS CURRENT SOURCE

2. IMPRESSED CURRENT USES AN OUTSIDE DC CURRENT SOURCE TO IMPRESS OR FORCE CURRENT ONTO STRUCTURE.

QUESTIONS

6a. What is the difference between a galvanic anode system and an impressed current CP system?

6b. When is a galvanic anode system normally used?

6c. When is an impressed current system normally used?

CATHODIC PROTECTION TYPES

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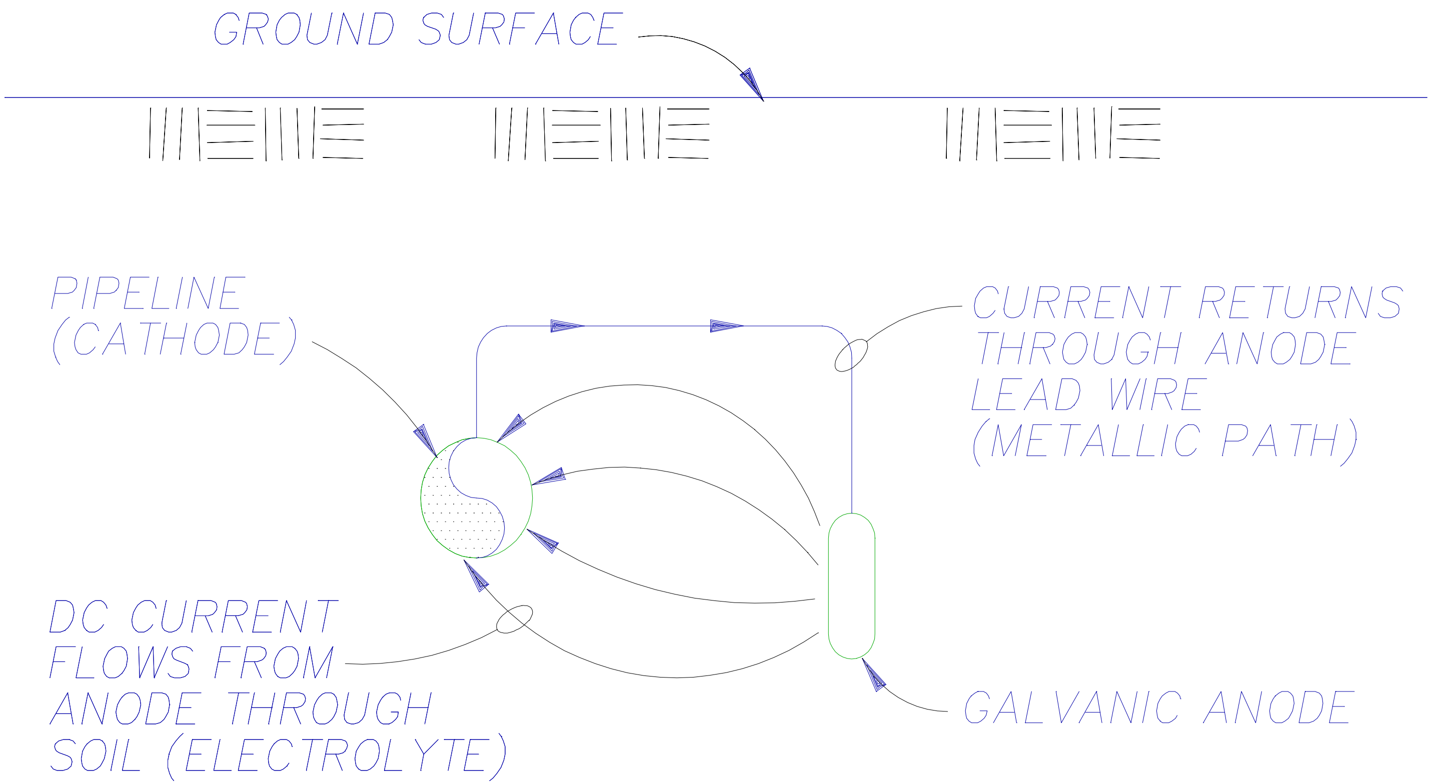
DETAIL W-6

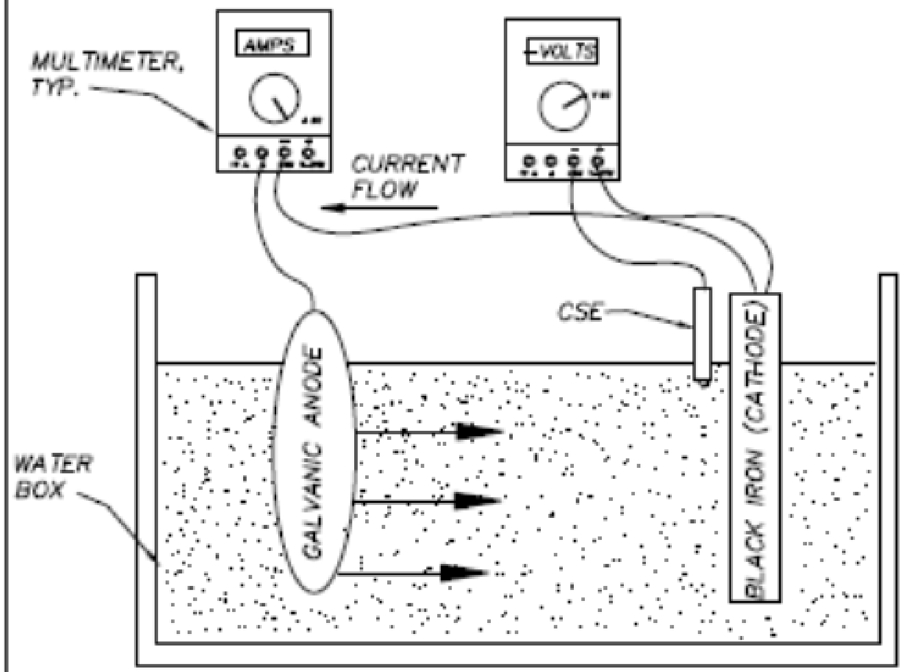
Water Box Rectifier (Adjustable DC Power Supply)

W-6 Galvanic Anode CP Protection



GALVANIC ANODE CATHODIC PROTECTION

DEMONSTRATION: The effect of commonly used galvanic anode materials on the potential of iron pipe is shown.



QUESTIONS

6a. What factors determine the current output of a galvanic anode?

6b. When should zinc be the first material considered for a galvanic anode?

6c. When should magnesium be the first material considered for an anode?

6d. Why are buried galvanic anodes normally prepackaged?

GALVANIC ANODE CATHODIC PROTECTION

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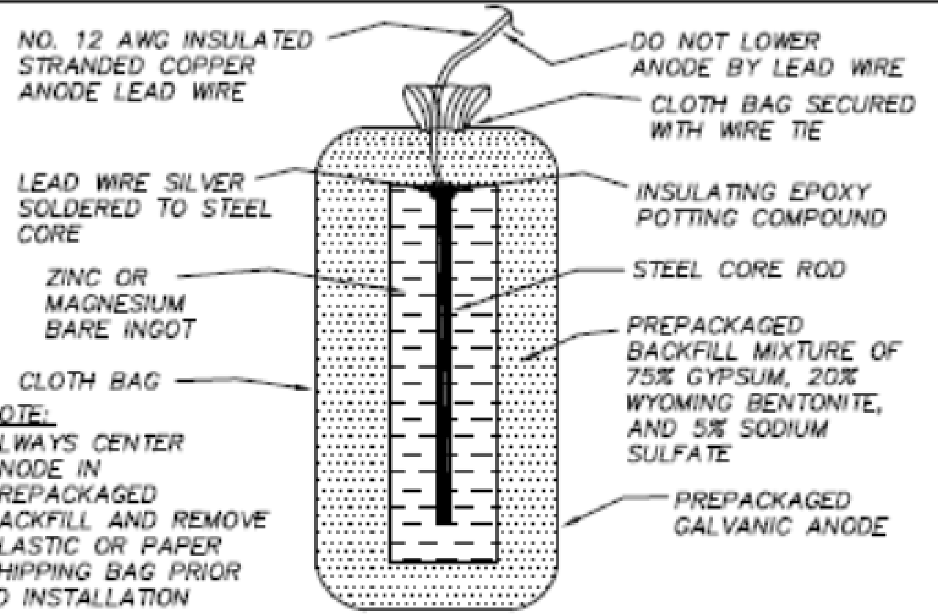
DETAIL W-6B



NOTE:
ALWAYS CENTER ANODE IN PREPACKAGED BACKFILL AND REMOVE PLASTIC OR PAPER SHIPPING BAG PRIOR TO INSTALLATION

TYPICAL GALVANIC ANODES FOR SOIL CONDITIONS

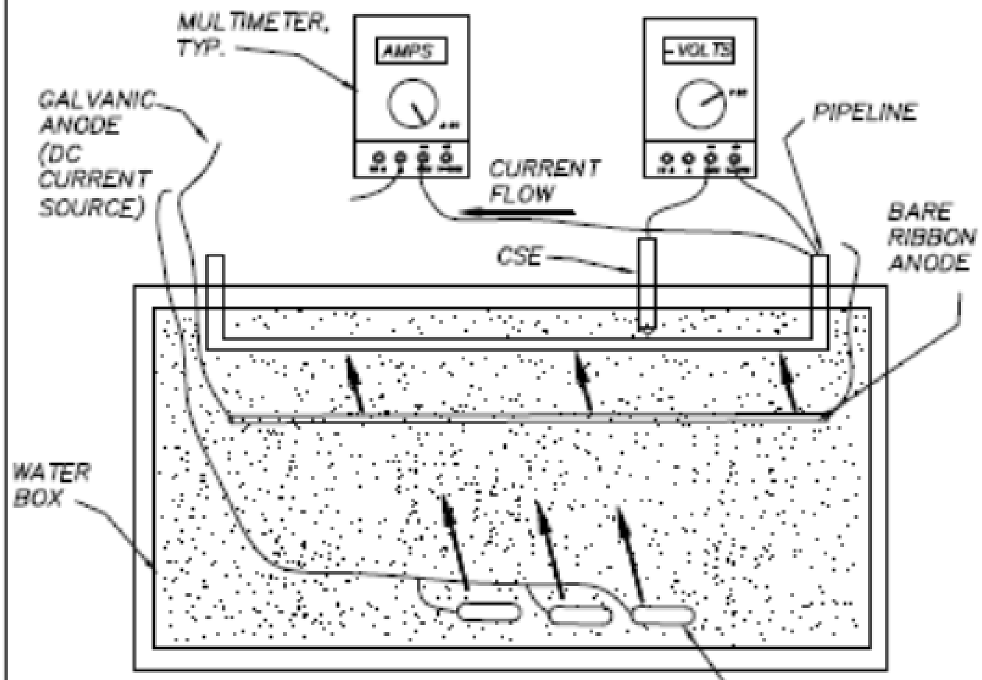
ANODE TYPE:	ZINC			HI-POT MAGNESIUM		
SELECT WHEN:	SOILS <1,500 OHM-CM			SOILS >1,500 OHM-CM & LEAKS WHERE ONLY 5 PLUS YEAR ANODE LIFE DESIRED		
DRIVING VOLTAGE:	-1.1 VOLTS			-1.6 TO -1.7 VOLTS		
ANODE COMPOSITION:	ASTM B418 TYPE II			ASTM B843 W/ALLOY M1C HIGH POTENTIAL		
BARE ANODE WEIGHT:	5 PD	18 PD	30 PD	5 PD	17 PD	32 PD
ANODE SHAPE:	ZUR-5	ZUR-18	ZUR-30	5D3	17D3	32D5
BARE ANODE DIMENSIONS:	1.4"X9"	1.4"X36"	2"X30"	3"X7"	3"X25"	5"X20"
APPROX. PACKAGED WEIGHT	16 PD	70 PD	70 PD	14 PD	42 PD	68 PD
NOMINAL PACKAGE DIMENSIONS:	4.5"X12"	5"X42"	5"X38"	5"X13"	6"X29"	7"X28"
NORMALLY USED WHEN:	SINGLE SMALL FITTINGS	PIPE AND LARGER FITTINGS	HIGH OUTPUT REQ'D. W/LONG LIFE	SINGLE SMALL FITTINGS	PIPE AND LARGER FITTINGS OR LEAKS	HIGH OUTPUT REQ'D. W/LONG LIFE OR LEAKS

PREPACKAGED GALVANIC ANODES

 NTS

FIGURE W-6C

DEMONSTRATION: Commonly used galvanic anode types are discussed.



TYPICAL GALVANIC ANODE TYPES

Material Types Soil: Zn, Mg, Al (sea water)
Shapes: Individual, Anode Strings, Ribbon
Backfill: Prepackaged or Bare

QUESTIONS

6a. What advantages/disadvantages do an anode string have?

6b. What are advantages/disadvantages of a ribbon anode?

6c. Why do you have to remove the plastic shipping bag on prepackaged anodes?

GALVANIC ANODE TYPES

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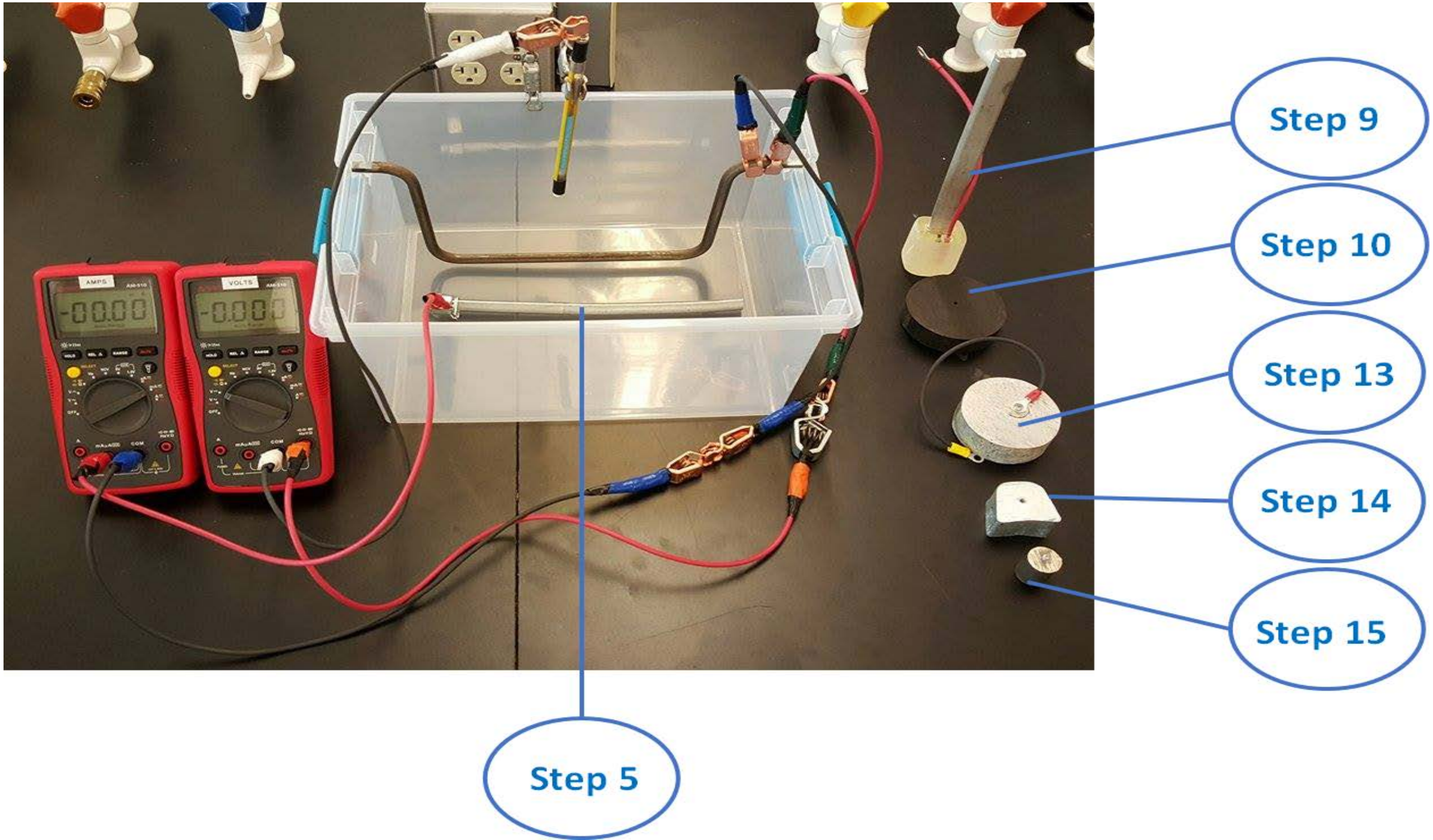
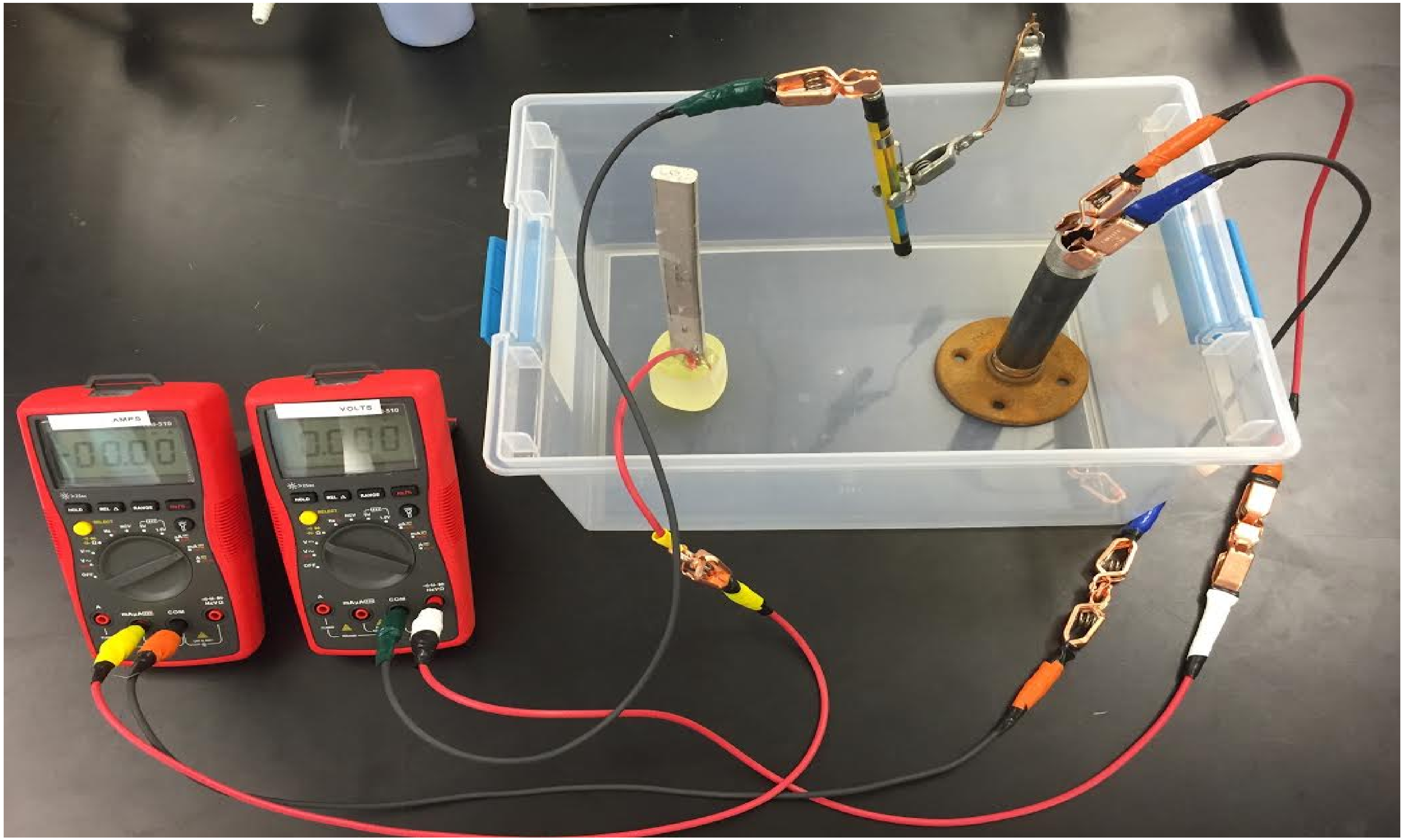
DETAIL W-6A

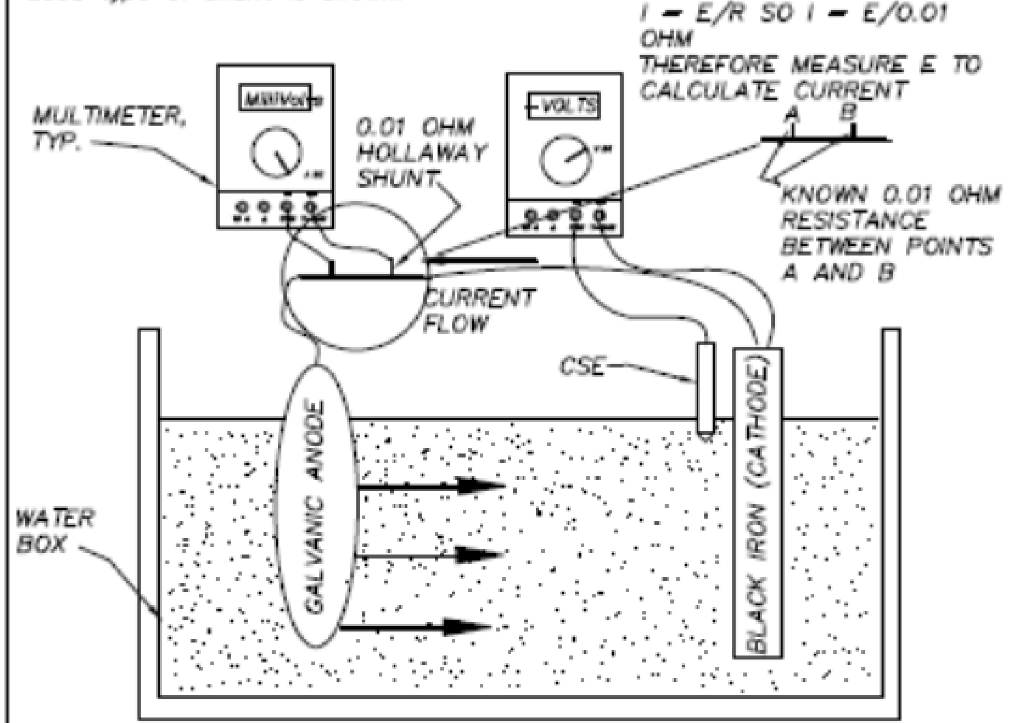
W-6A Galvanic Anode Types



W-6B Galvanic Anode Cathodic Protection



DEMONSTRATION: The ability to measure current flow with a commonly used type of shunt is shown.



Shunt Rating For A 0.01 Ohm Shunt 1 MV = 100 MilliAmps Current Flow

Zinc Anode Life = $\frac{28.68\ (W)}{mA}$ Magnesium Anode Life = $\frac{42.81(W)}{mA}$

Where L = Anode Life in Years, W = Original Bare Anode Weight in Pounds, mA = Anode Current Output in MilliAmps

QUESTIONS

7a. When is using a shunt beneficial?

7b. If the voltage (E) measured across a 0.01 ohm shunt is 0.25 millivolts, what is the current flow amount in milliamps?

7c. What would a 18 pound zinc anode life be? A 17 pound magnesium anode life?

CURRENT FLOW MEASUREMENTS WITH AN EXTERIOR SHUNT

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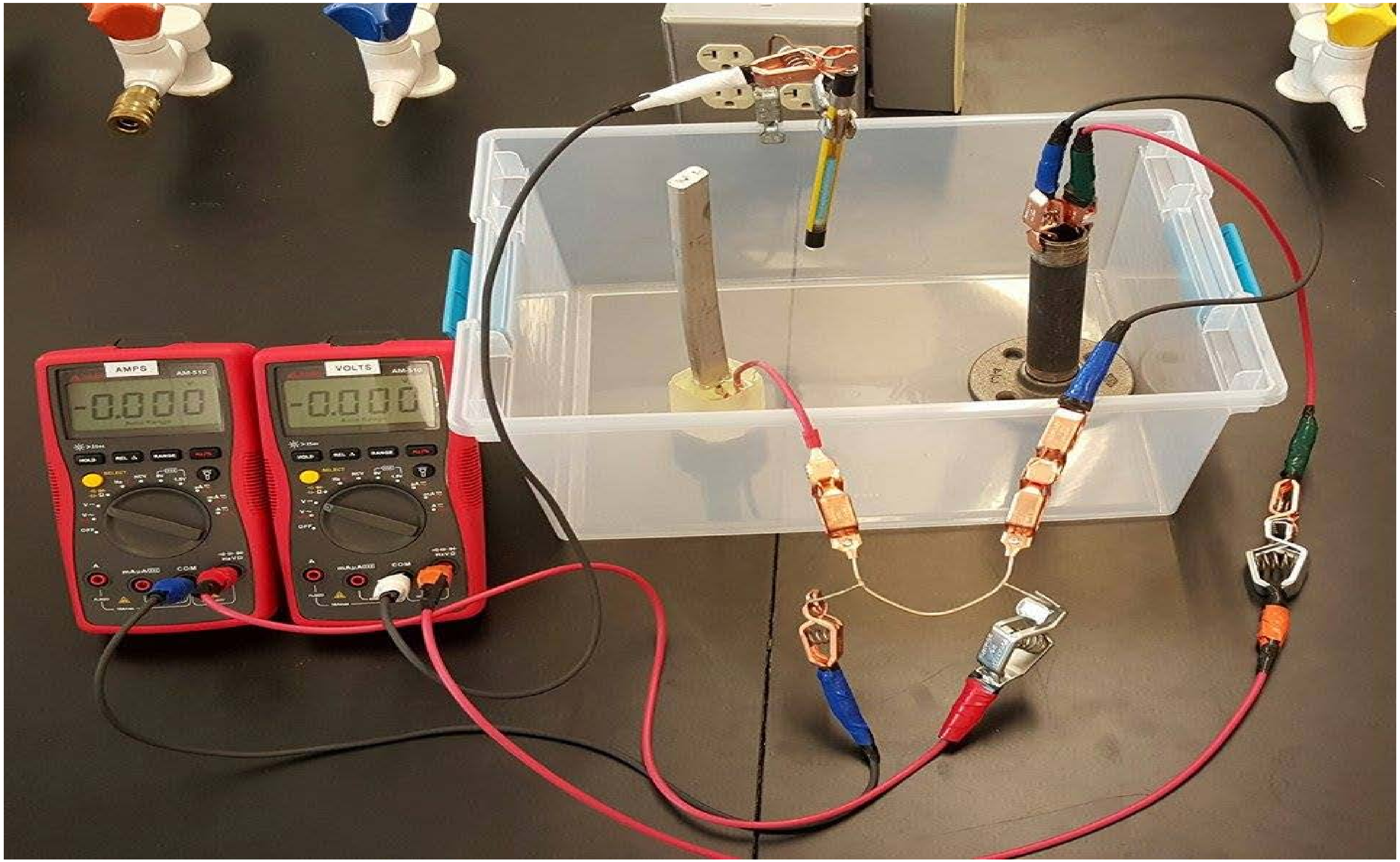
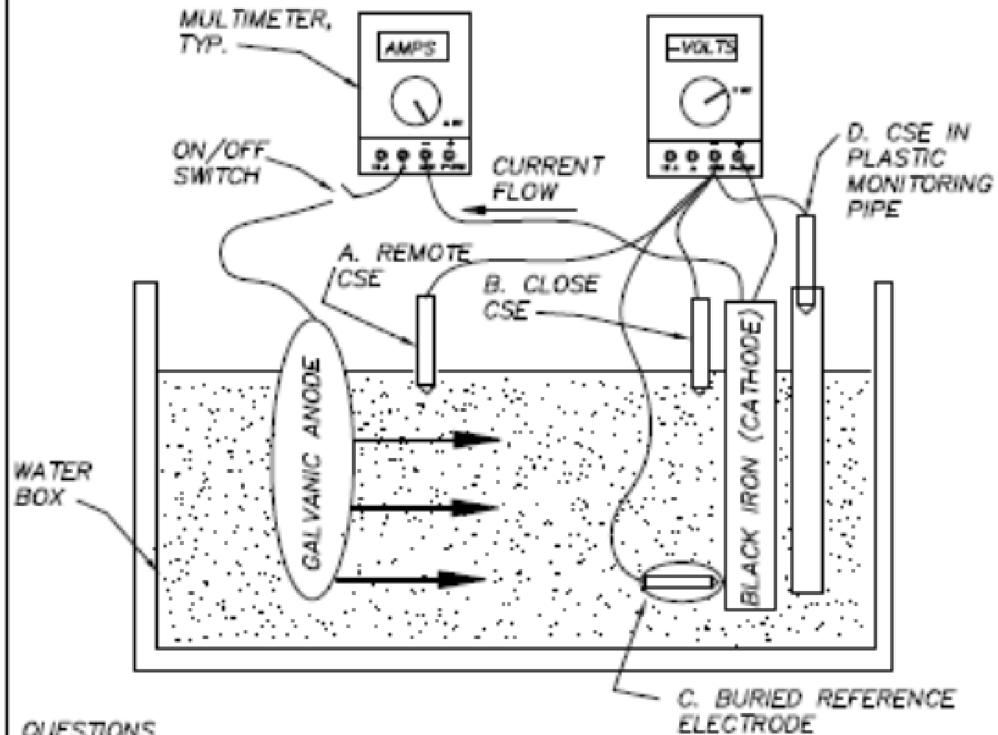
DETAIL W-7

W-7 Current Flow with External Shunt



DEMONSTRATION: Various methods of potential measurements are demonstrated.



QUESTIONS

8a. How does the location of the reference electrode influence the potential measurement?

8b. How can IR Drop influence potential measurements?

8c. How can IR Drop be accounted for in the measurements?

8d. What types of buried permanent reference electrodes are used?

POTENTIAL MEASUREMENT METHODS

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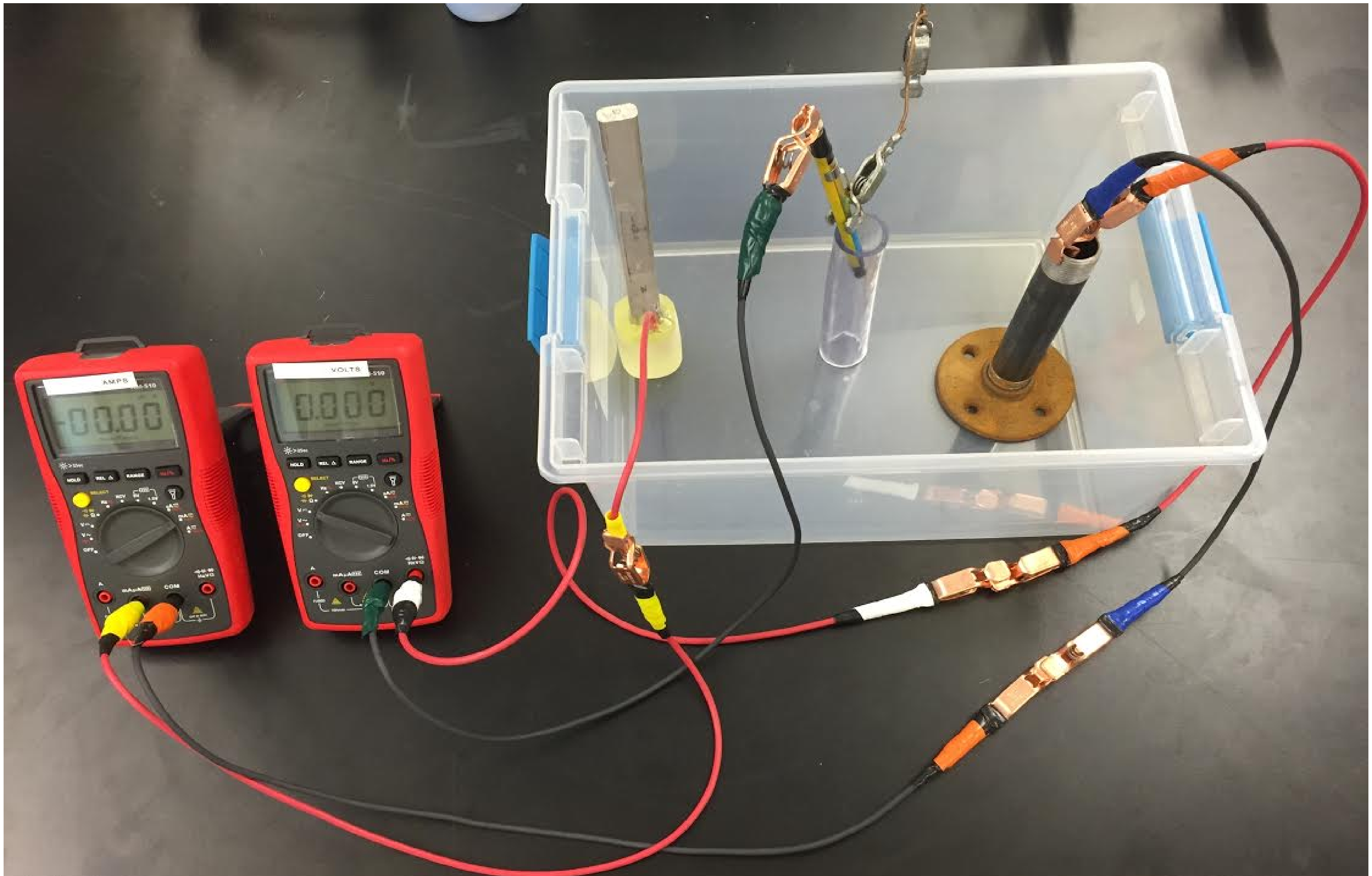
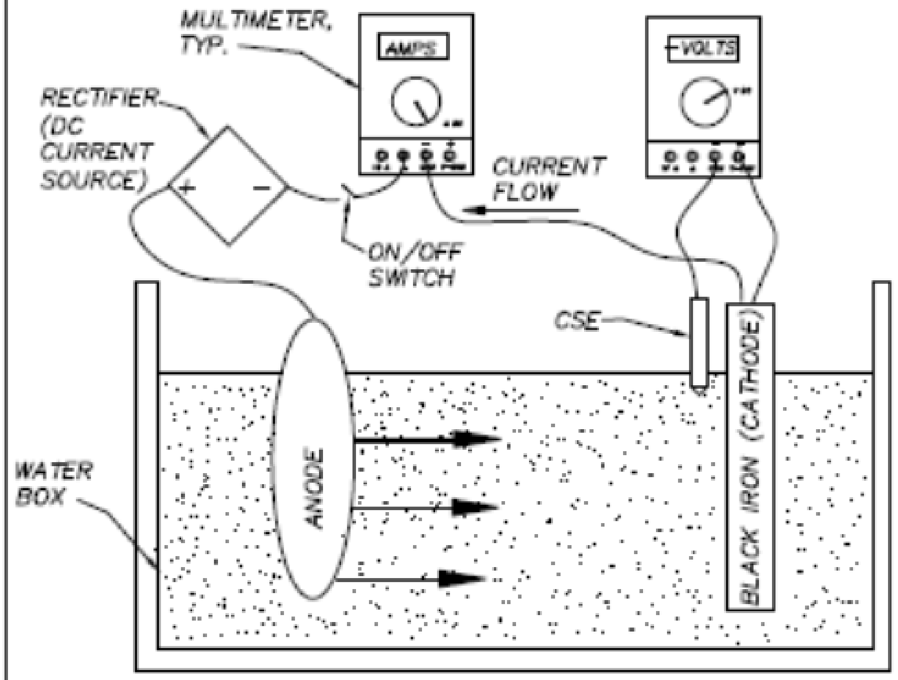
DETAIL W-8

W-8 Potential Measurement Methods



DEMONSTRATION: The effect of commonly used impressed current cathodic protection systems on the potential of iron pipe is shown.



QUESTIONS

9a. How is the structure-to-electrolyte (or pipe-to-soil) potential value controlled?

9b. What should the polarity of the current source connection to the structure be? To the impressed current anode?

9c. What happens if the current source output polarity is reversed?

9d. What types of DC current sources are commercially available?

IMPRESSED CURRENT CATHODIC PROTECTION

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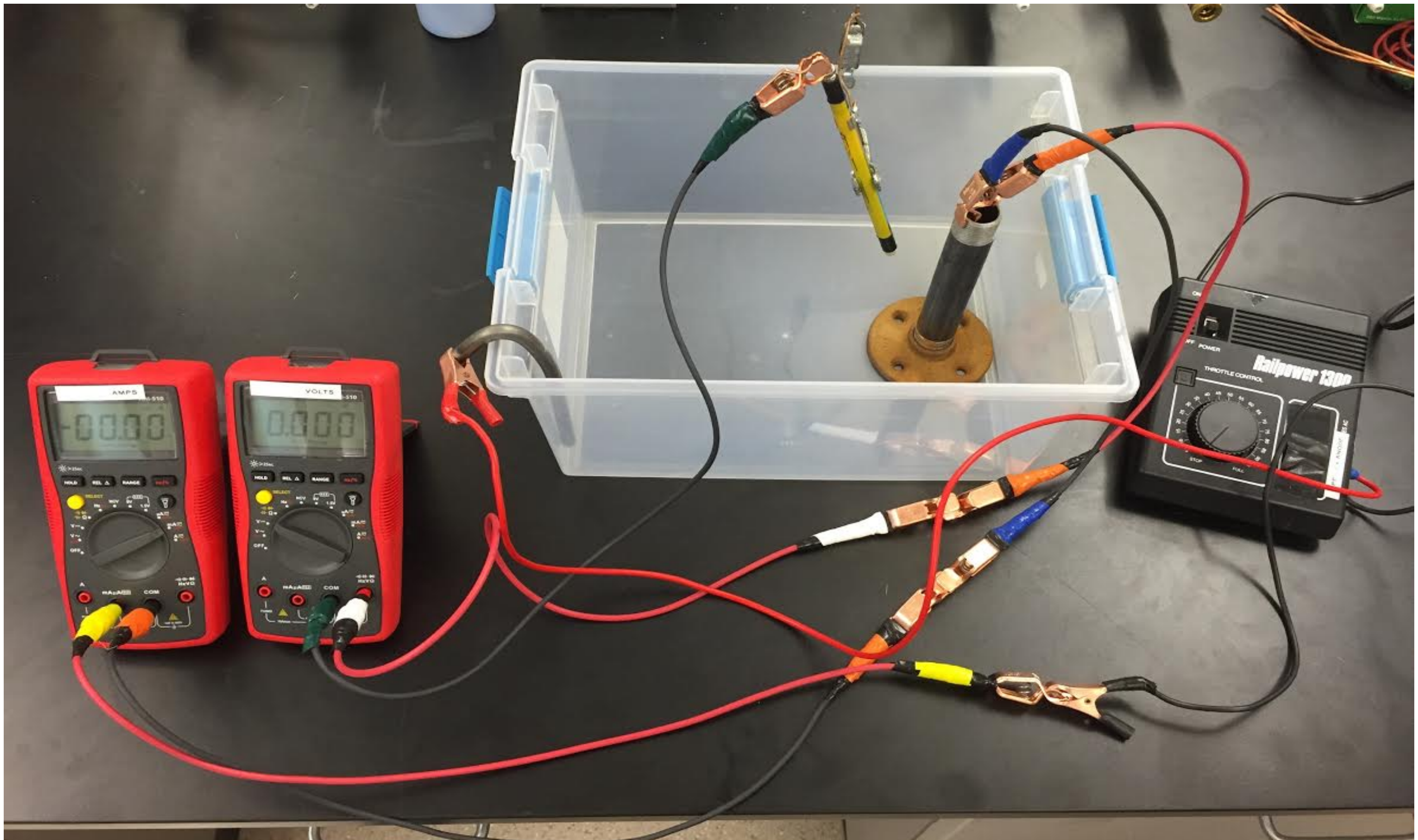
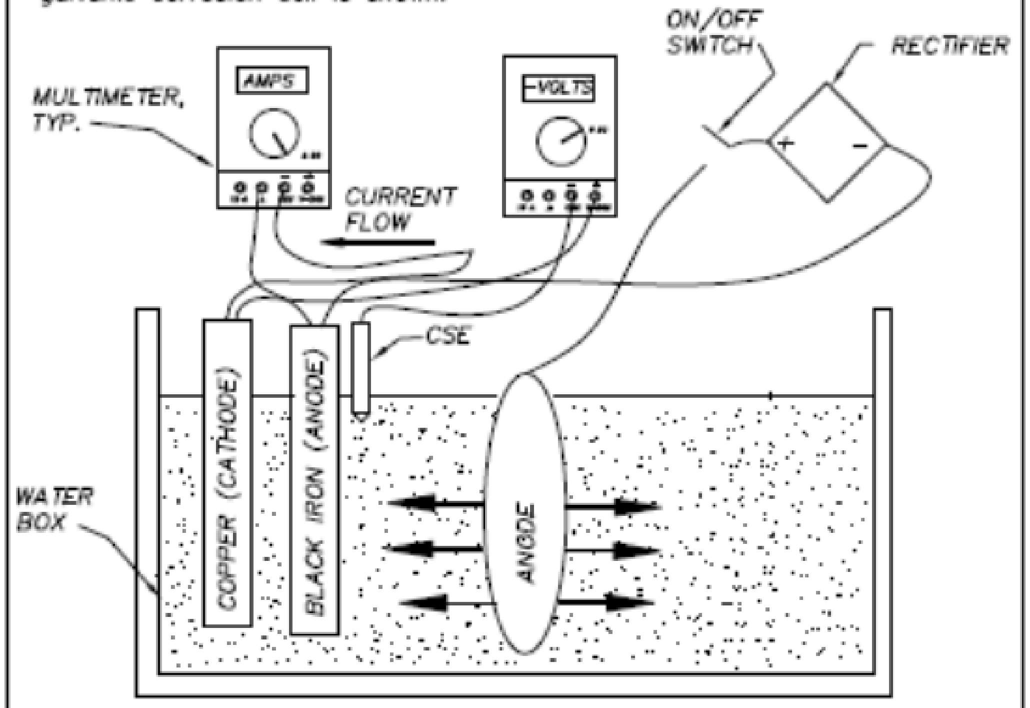
DETAIL W-9

W-9 Impressed Current Cathodic Protection Type System



DEMONSTRATION: Cathodic protection influence on current flow in a galvanic corrosion cell is shown.



QUESTIONS

10a. When is the amount of cathodic protection current adequate to stop all corrosion cells?

10b. What is one of the NACE criteria for cathodic protection of iron? Advantages/Disadvantages?

10c. What is another NACE criteria that can be used to demonstrate protected levels for iron? Advantages/disadvantages?

CATHODIC PROTECTION LEVELS

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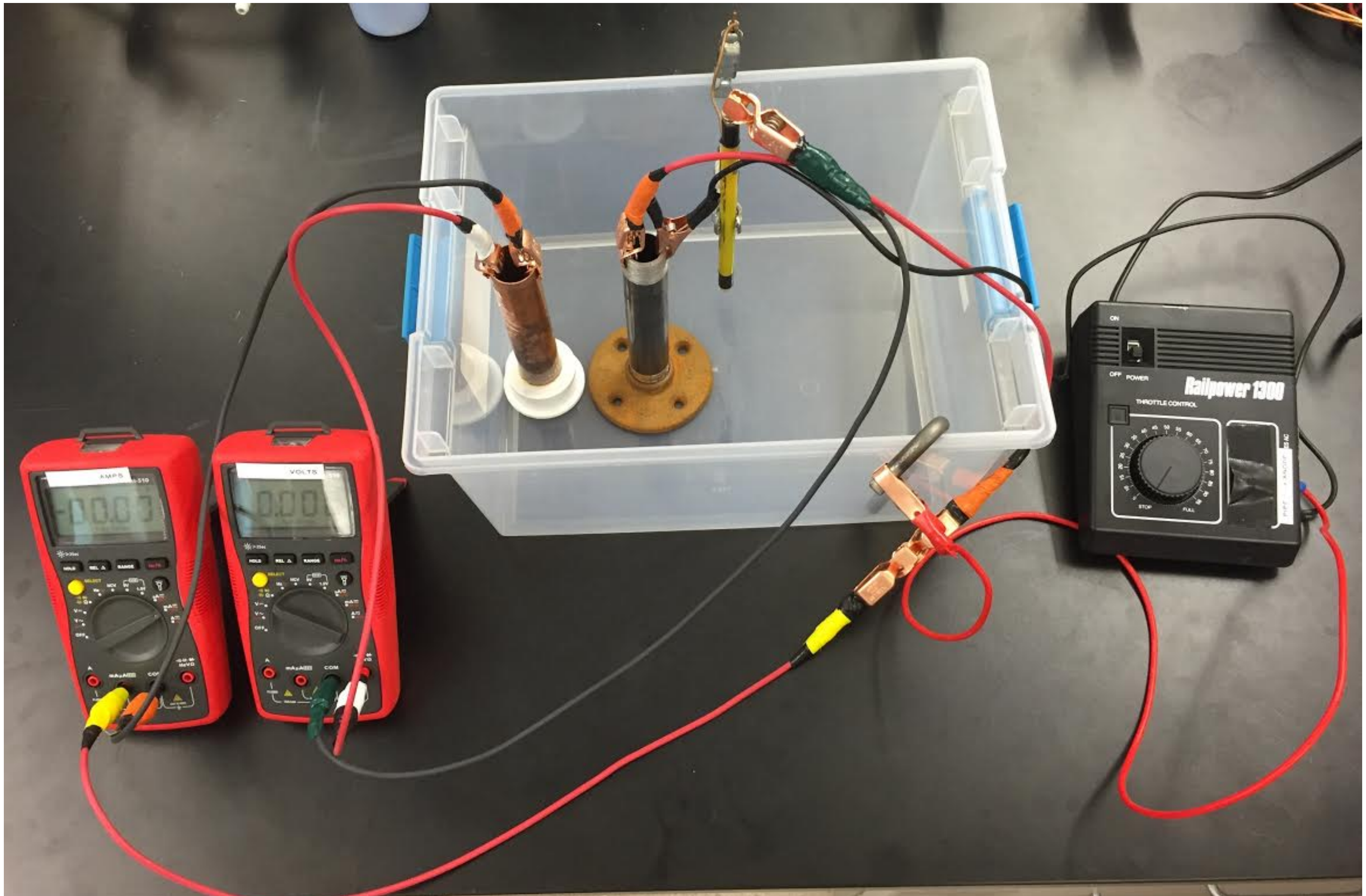
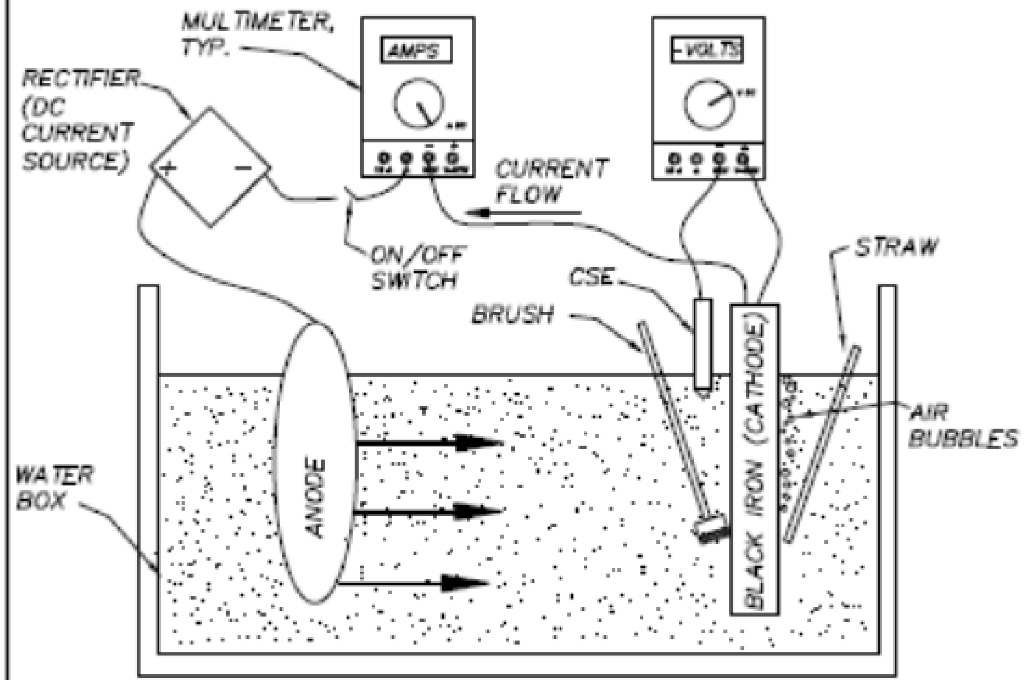
DETAIL W-10

W-10 Cathodic Protection Levels



DEMONSTRATION: The effect of polarization with cathodic protection systems on the potential and current flow of iron pipe is shown.



QUESTIONS

11a. What is polarization? How is it created?

11b. How does polarization provide a benefit with cathodic protection?

11c. How long does it take for polarization to occur on a bare structure? On a well coated structure?

11d. What happens to the potential levels if the polarization is removed?

11e. What happens to the polarization if the current source output is halted?

CATHODIC PROTECTION POLARIZATION

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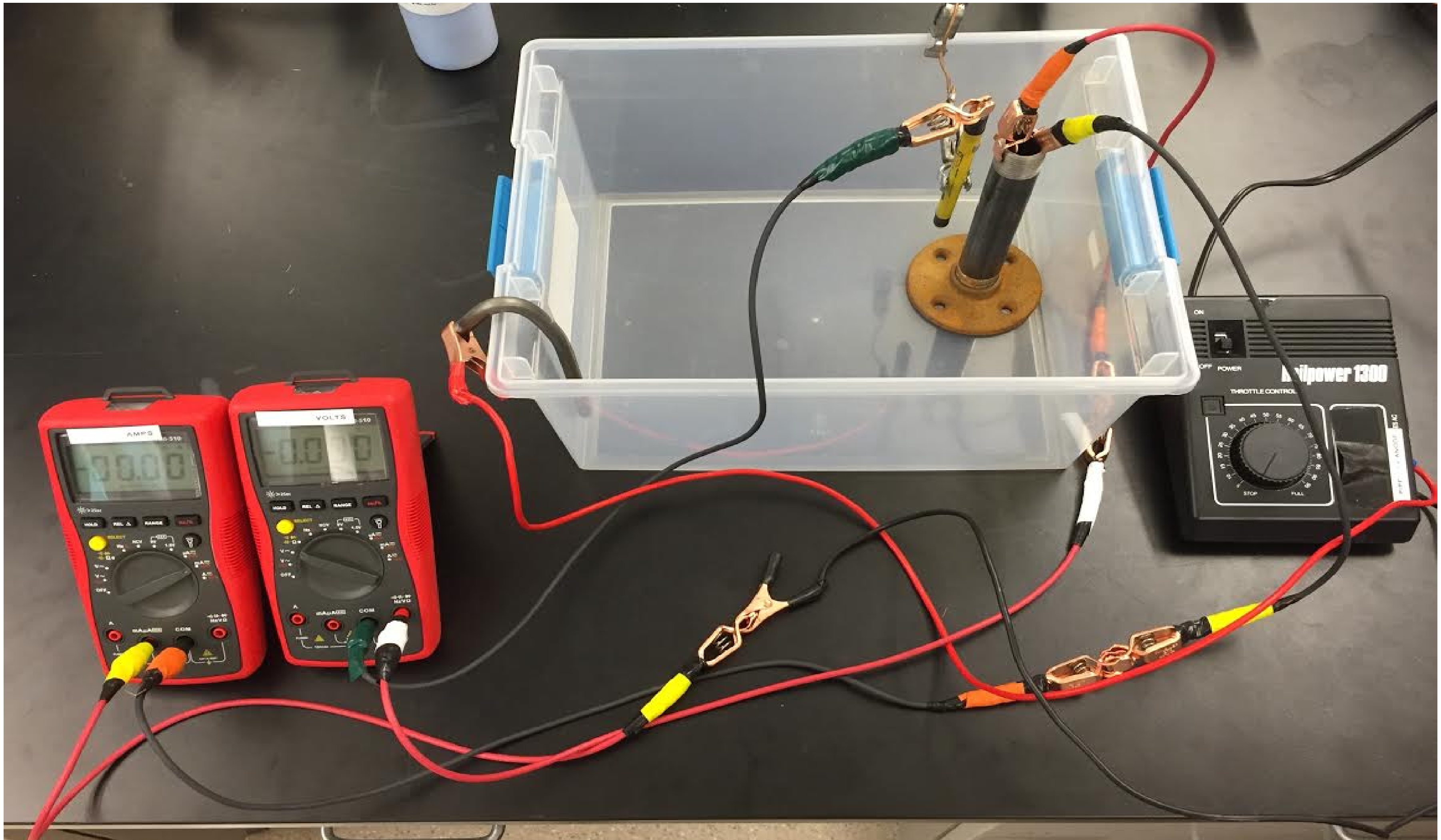
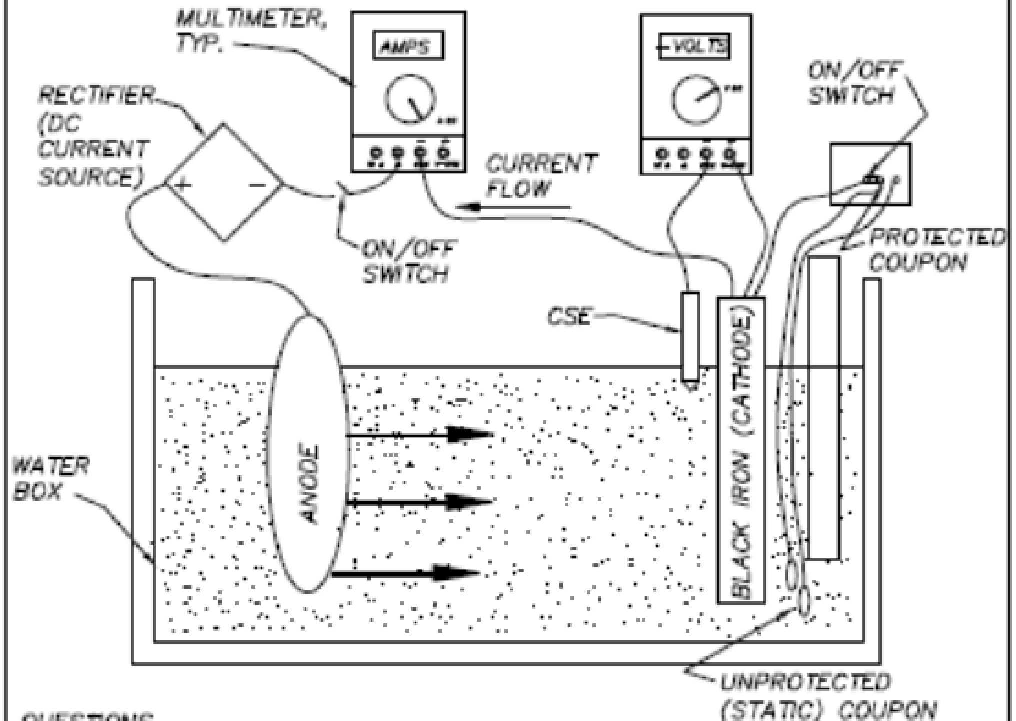
DETAIL W-11

W-11 Cathodic Protection Polarization



DEMONSTRATION: The use of coupons to monitor protection levels on a structure is shown.



QUESTIONS

12a. How can coupons be used to show protection levels on a pipeline?

12b. Does the cathodic protection current source need to be turned off or disconnected to complete coupon testing?

12c. What is the minimum size the coupon should be? Why?

12d. What locations can coupons be used effectively?

POTENTIAL MEASUREMENTS USING COUPONS

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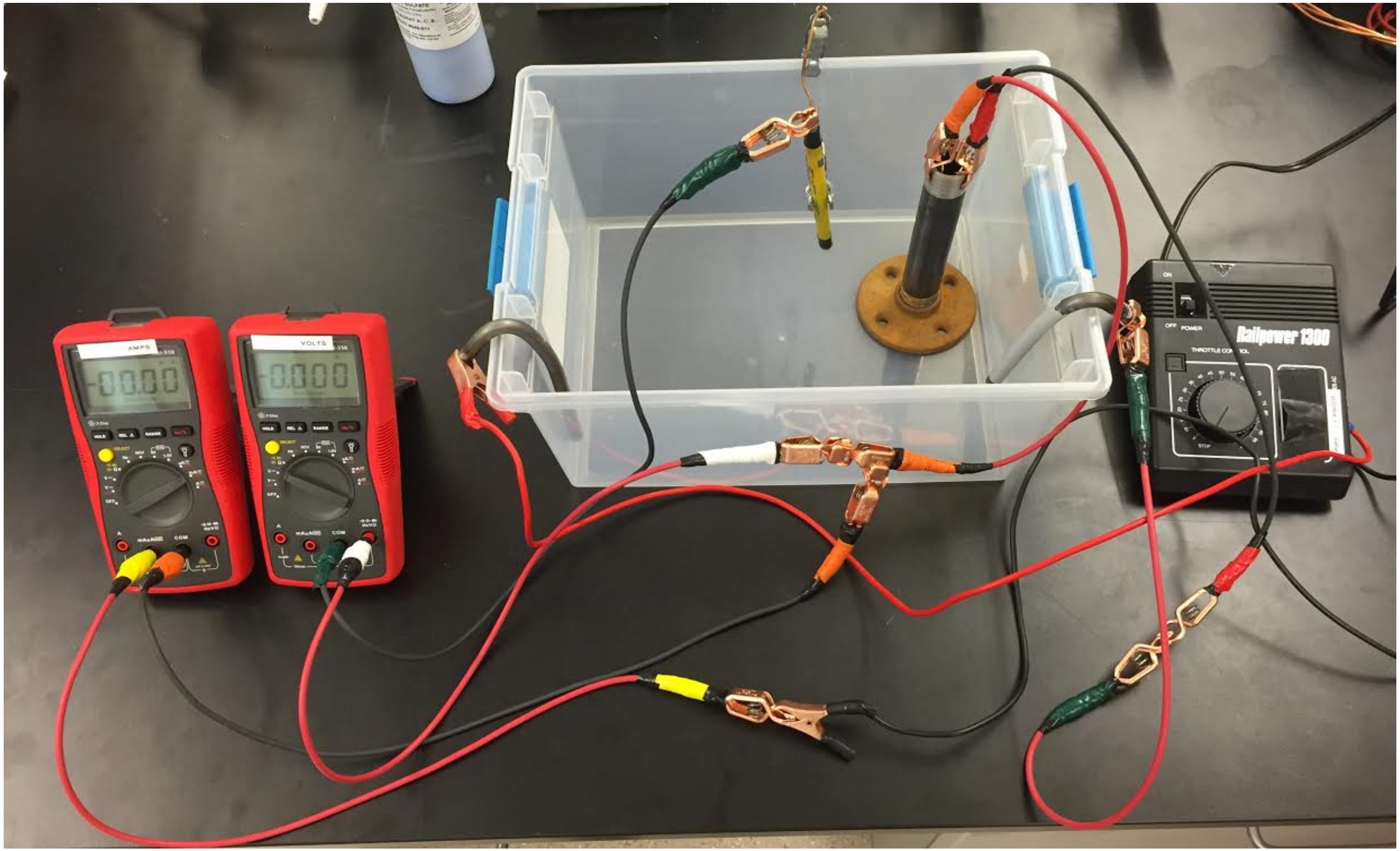
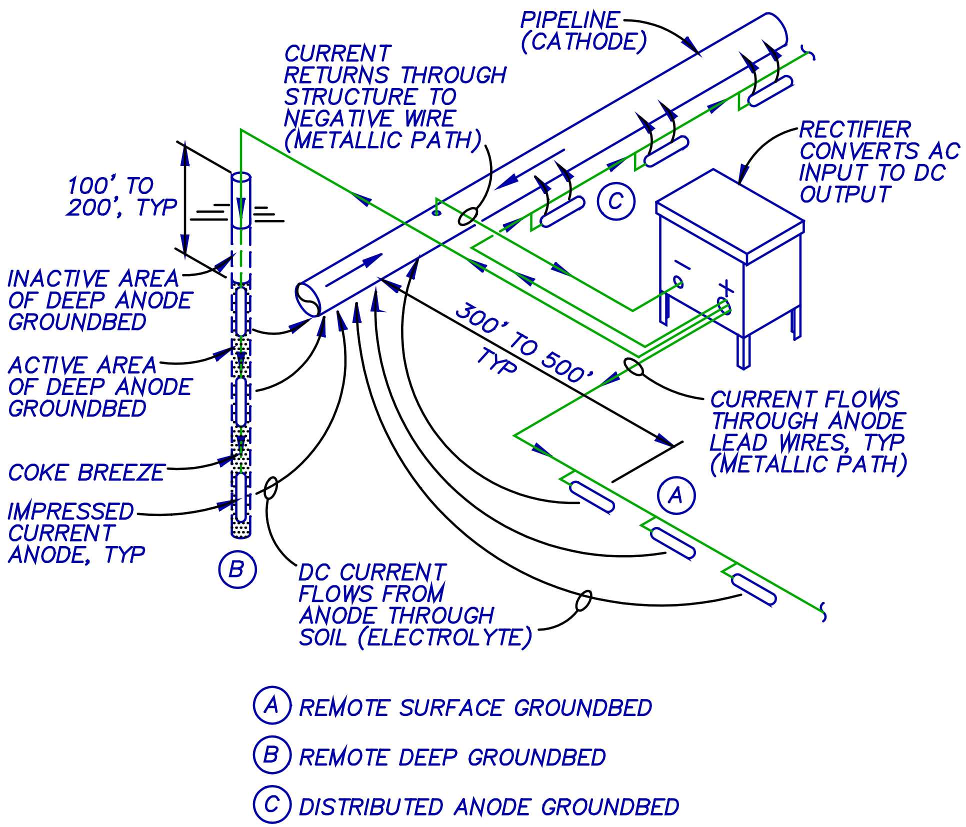
DETAIL W-12

W-12 Potential Measurements Using Coupons

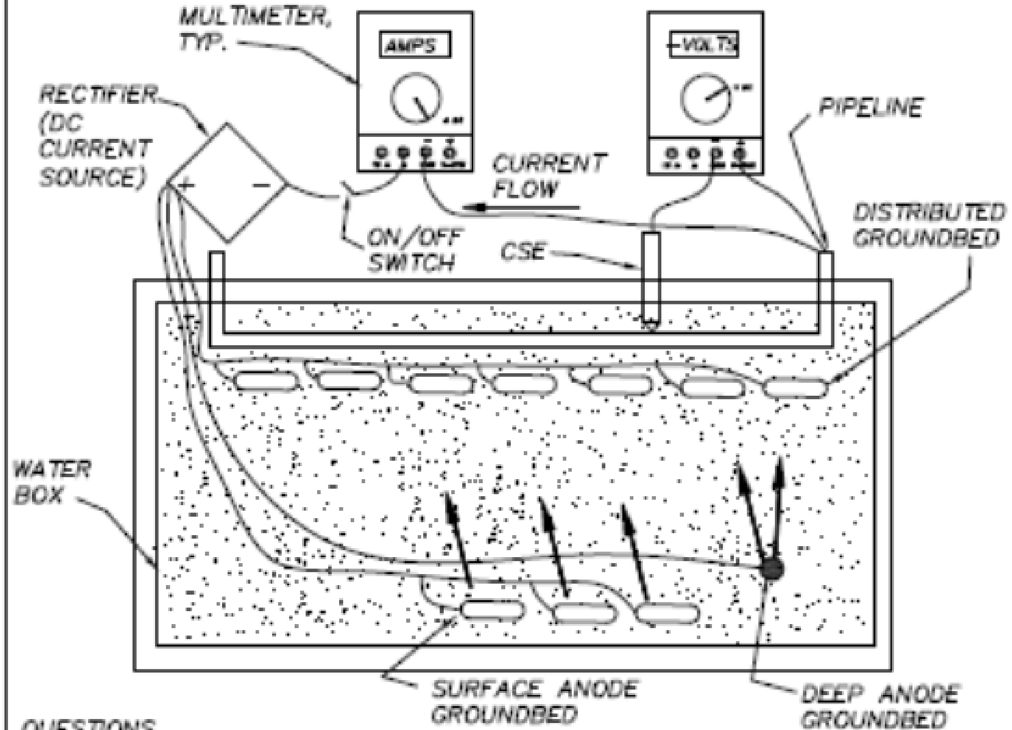


W-13 Impressed Current CP Systems



IMPRESSED CURRENT CATHODIC PROTECTION GROUNDBED TYPES

DEMONSTRATION: The effect of commonly used impressed current cathodic protection groundbed types on the potential of iron pipe is shown.



QUESTIONS

1.3a. What is the difference between an electrically remote groundbed and a close groudbed?

1.3b. What advantages/disadvantages do a deep groundbed offer?

1.3c. What are advantages/disadvantages of a surface groundbed?

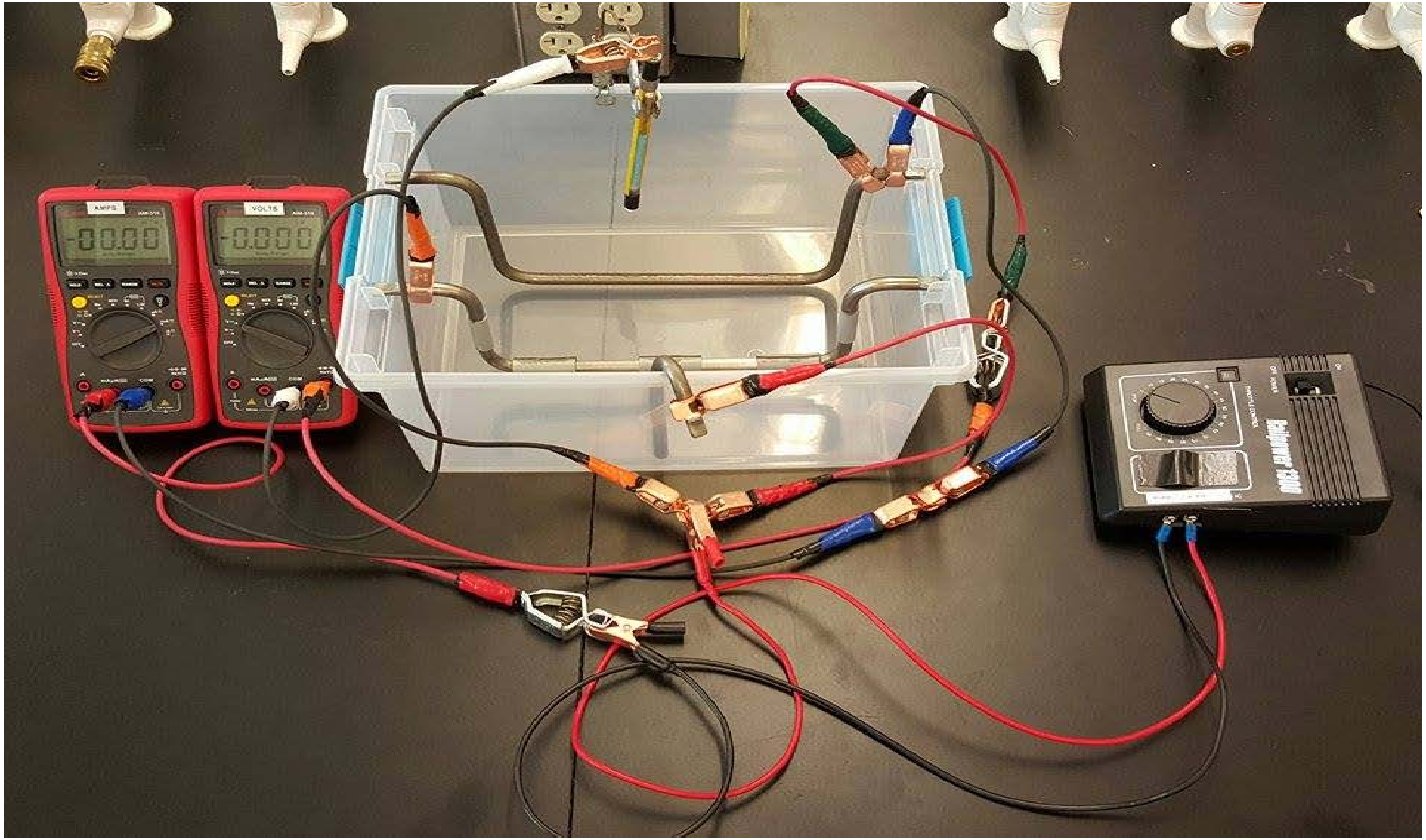
1.3d. What are the advantages/disadvantages of a distributed groundbed?

IMPRESSED CURRENT CATHODIC PROTECTION GROUNDBED TYPES

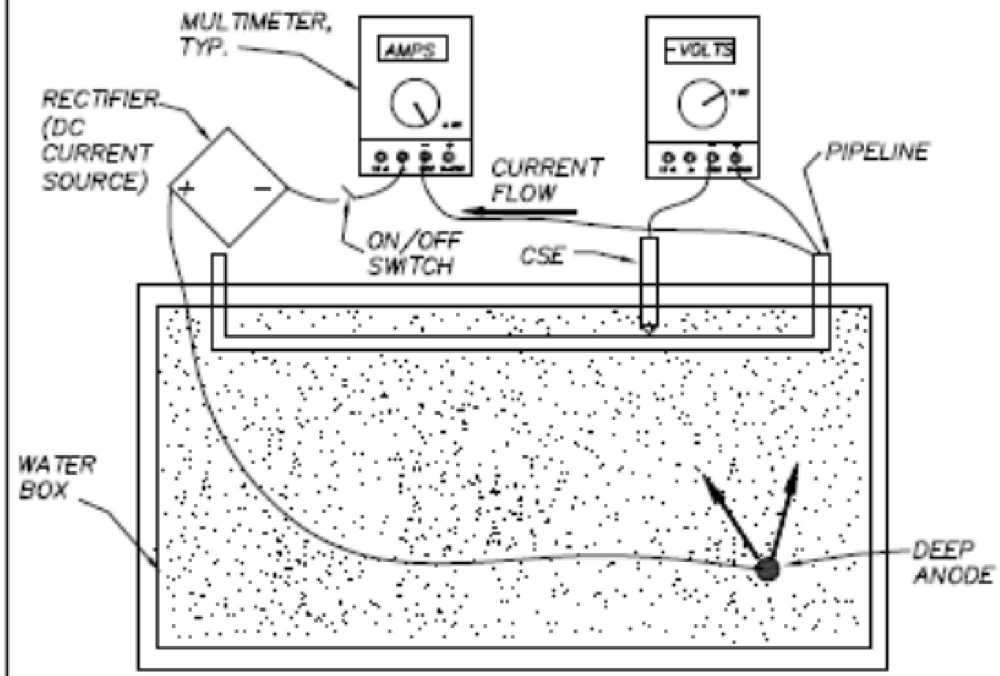
NTS

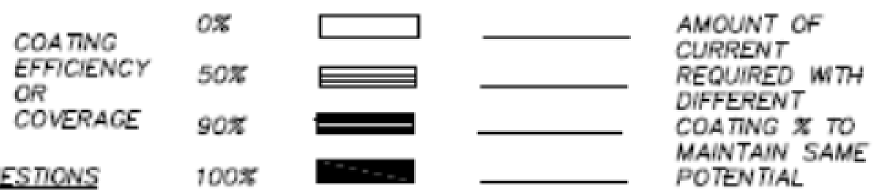
DETAIL W-13

W-13 Impressed Current CP Types



DEMONSTRATION: The effect of protective coating efficiency on the cathodic protection current requirement for a pipeline is shown.





QUESTIONS

14a. What is the effect of coating effiency on current requirement?

14.b Is it realistic to expect a perfectly coated structure? Why?

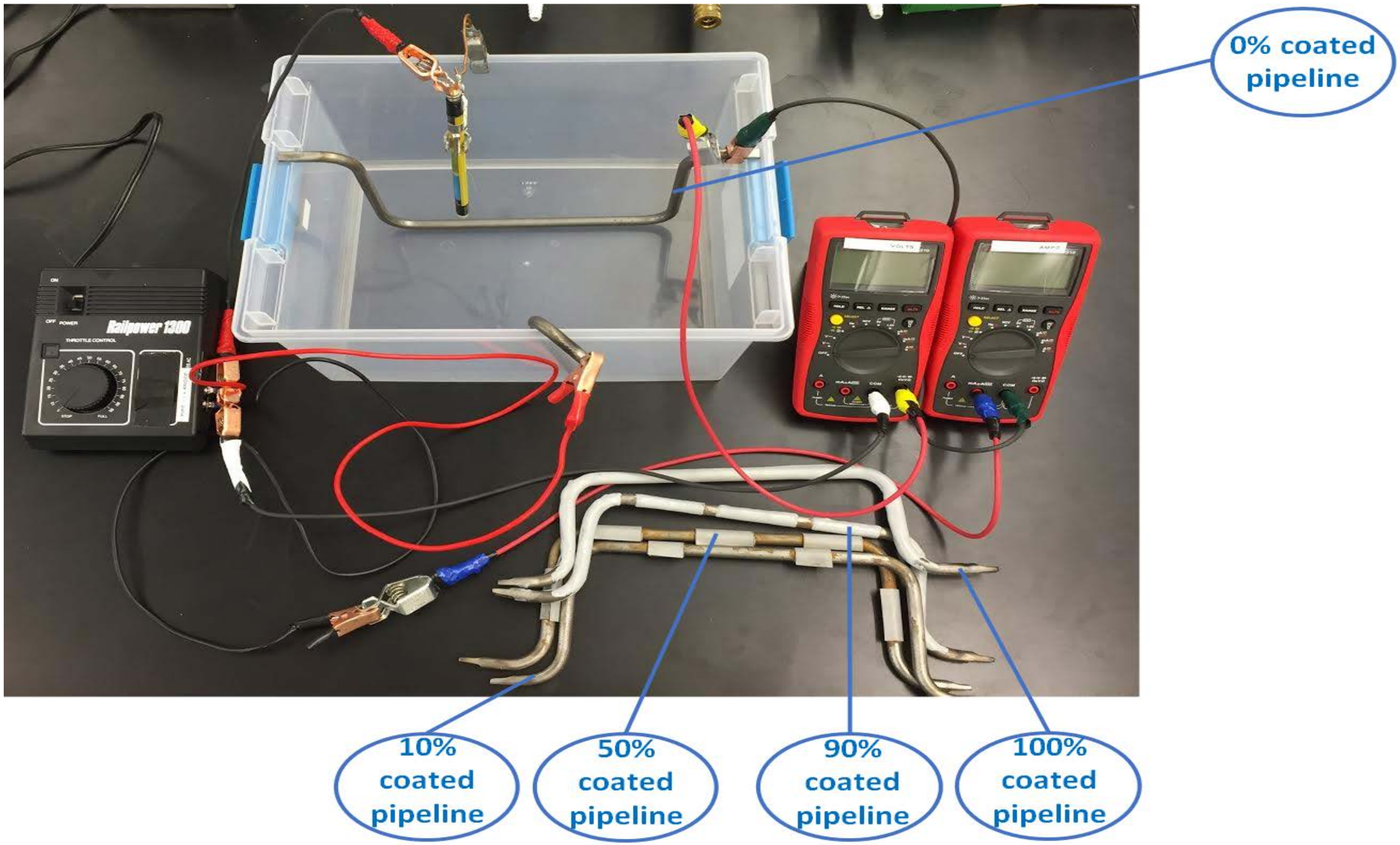
14c. What are the mutual benefits of protective coatings and cathodic protection?

TIGHT BONDED COATING EFFICIENCY

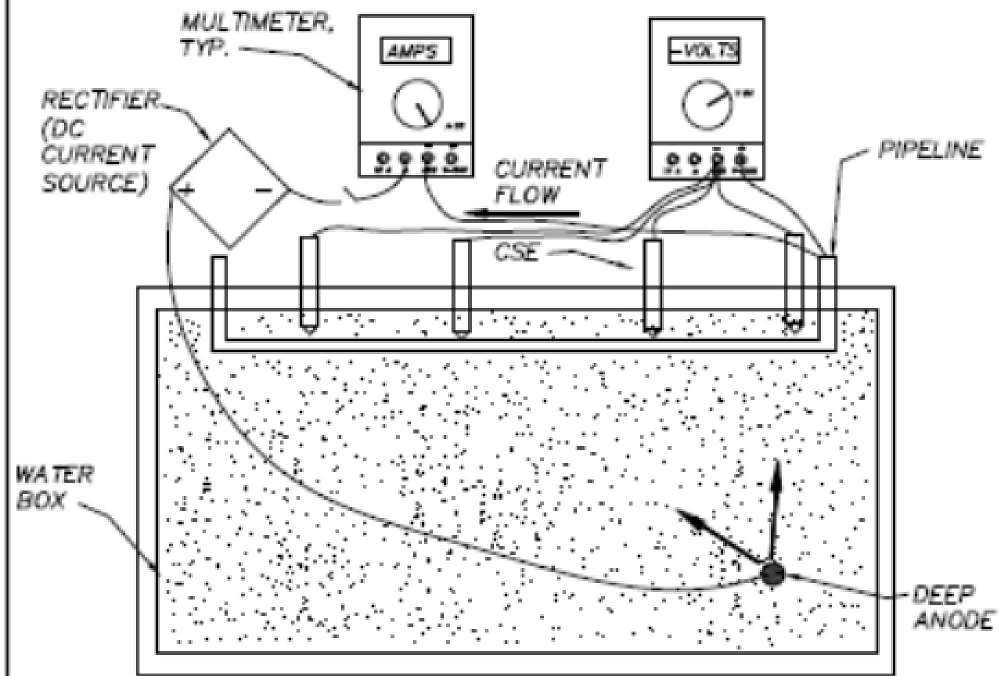
NTS

DETAIL W-14

W-14 Coating Efficiency Influence CP Requirements



DEMONSTRATION: The effect of attenuation and a potential profile along a pipeline is shown.



QUESTIONS

15a. What is attenuation?

15b Why is attenuation important during design and selection of groundbed locations and size?

15c. What factors influence potential profile along the pipeline?

15d. What is the potential (volts) when hydrogen gas evolution starts?

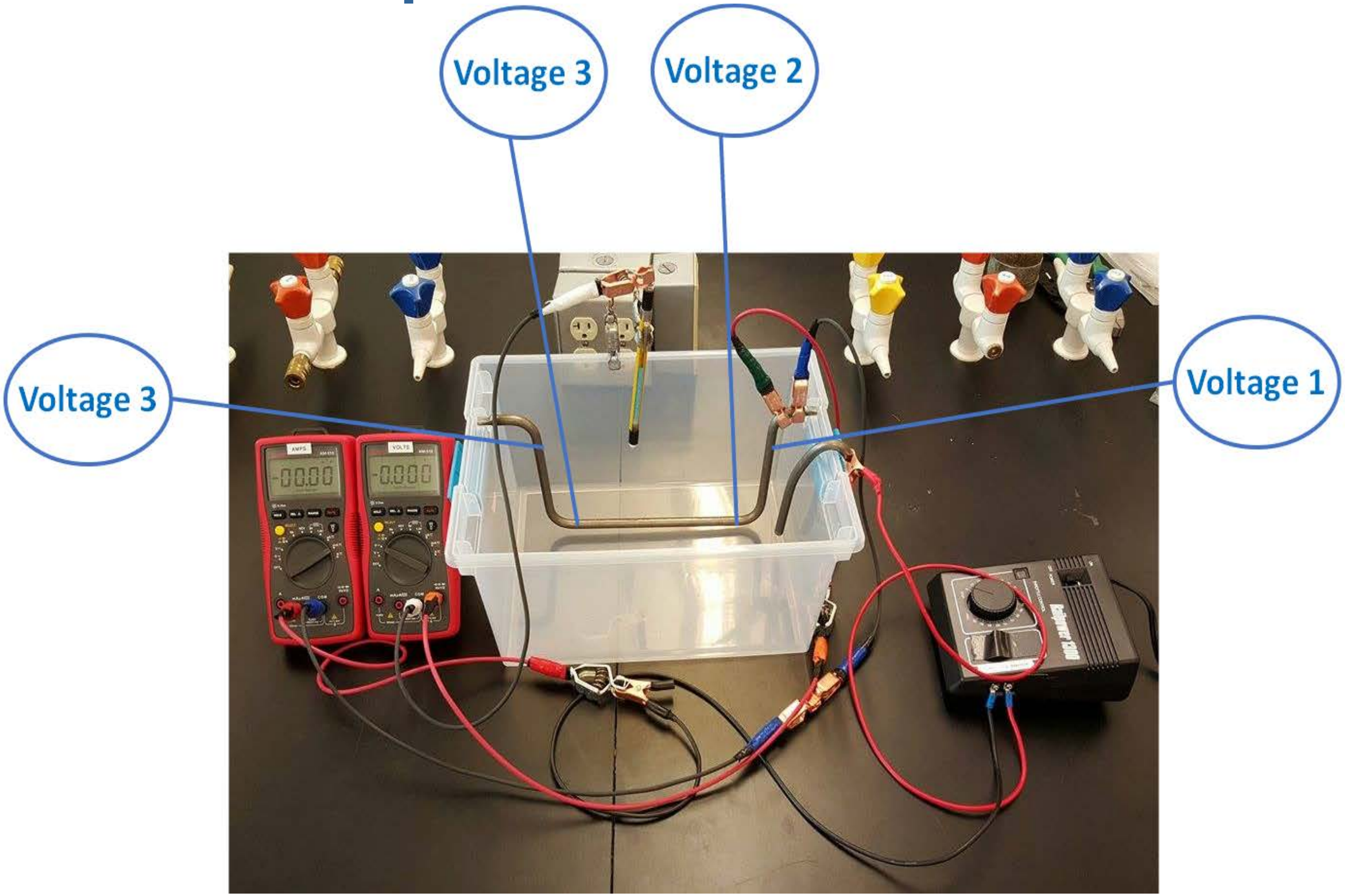
15e. What is the danger of too high of potentials on a pipeline?

PIPELINE ATTENUATION

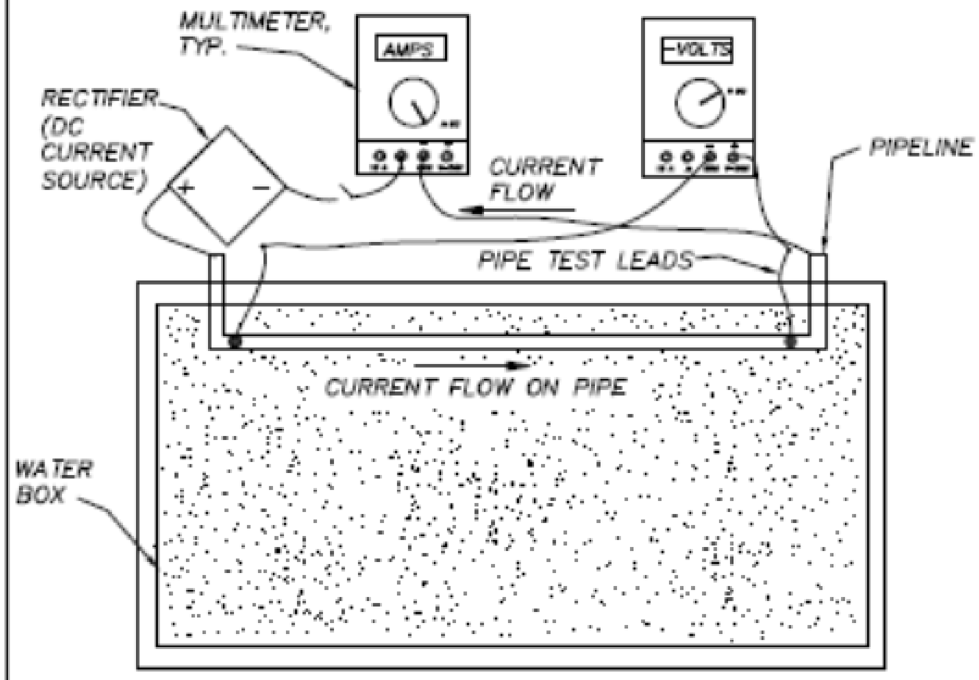
NTS

DETAIL W-15

W-15 Pipeline Attenuation



DEMONSTRATION: The method to calculate the resistance of a pipeline span is shown.



QUESTIONS

15Aa. How can one calculate the resistance for a given distance on the pipeline by Ohms Law (E=IR)?

15Ab. By knowing the distance between the test leads and the measured resistance, how can one calculate the K Factor (Resistance per Foot) for the pipeline?

15Ac. Will the K Factor (Resistance per Foot) be the same for dirrerent pipe diameter sizes?

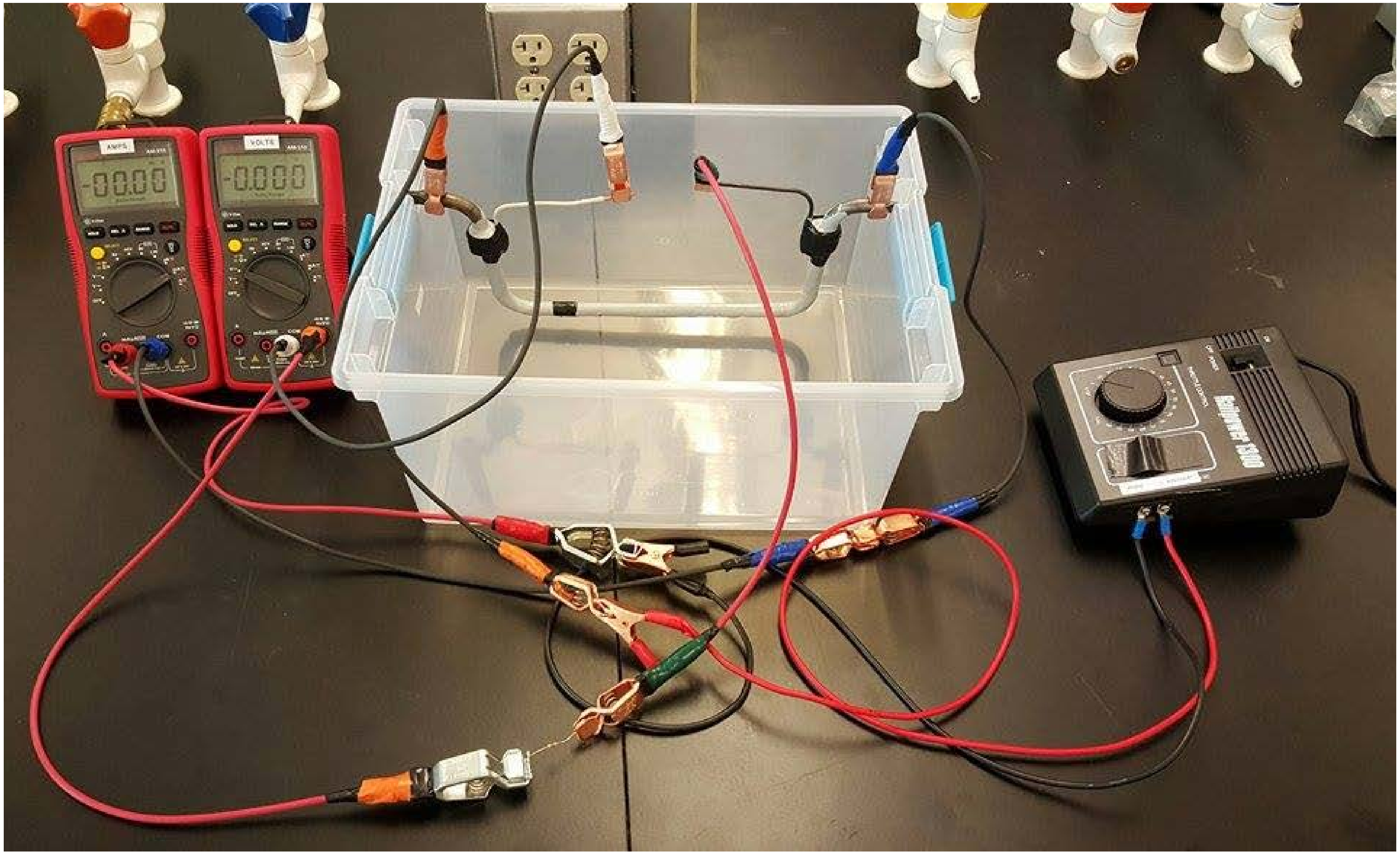
15Ad. For different pipe wall thicknesses (class)?

PIPELINE CURRENT SPAN

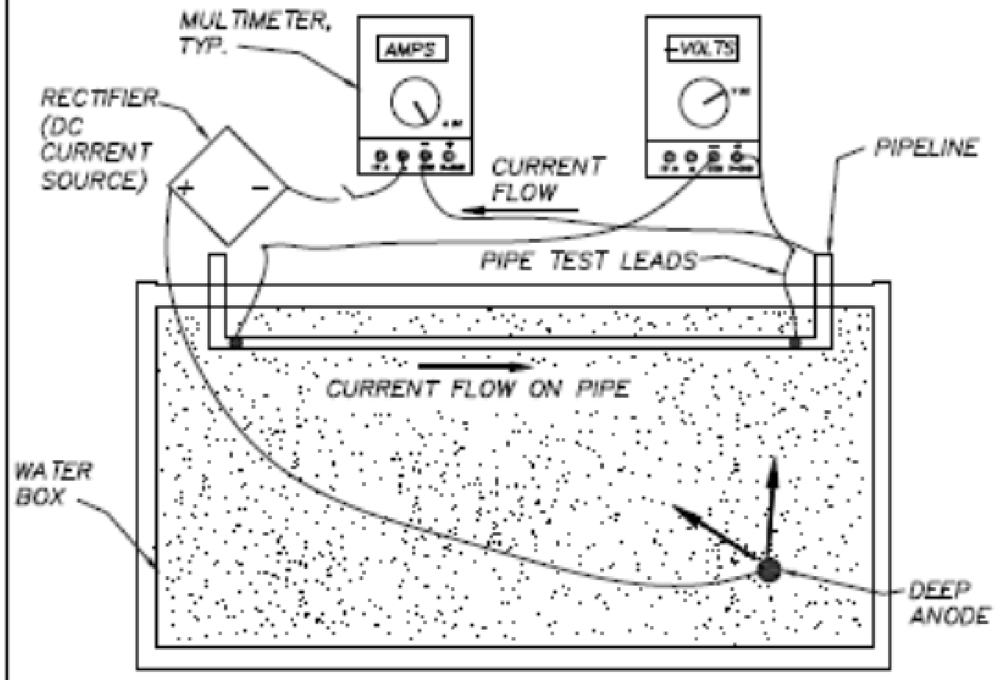
NTS

DETAIL W-15A

W-15A Pipeline Current Span



DEMONSTRATION: The effect of current flow from a cathodic protection system along a pipeline is shown.



QUESTIONS

15Ba. Why is there current flow on the pipeline?

15Bb. What is the source of the current flow?

15Bc. What direction does the current flow on the pipeline?

15Bd. What direction does the current flow in the cathodic protection system?

15Be. How can one calculate the amount of current flow by measuring the IR drop on the pipeline between two test leads?

PIPELINE CURRENT FLOW

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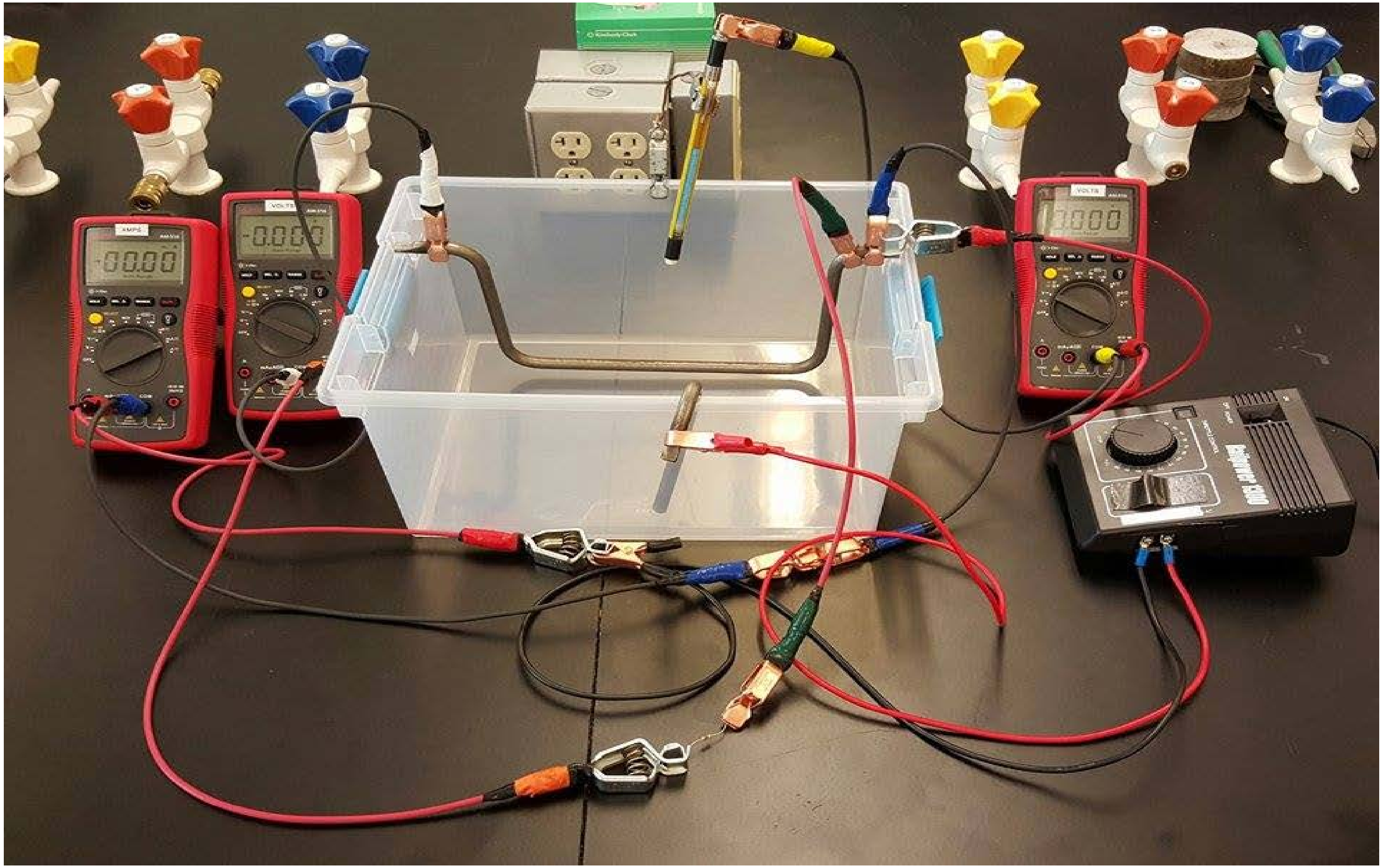
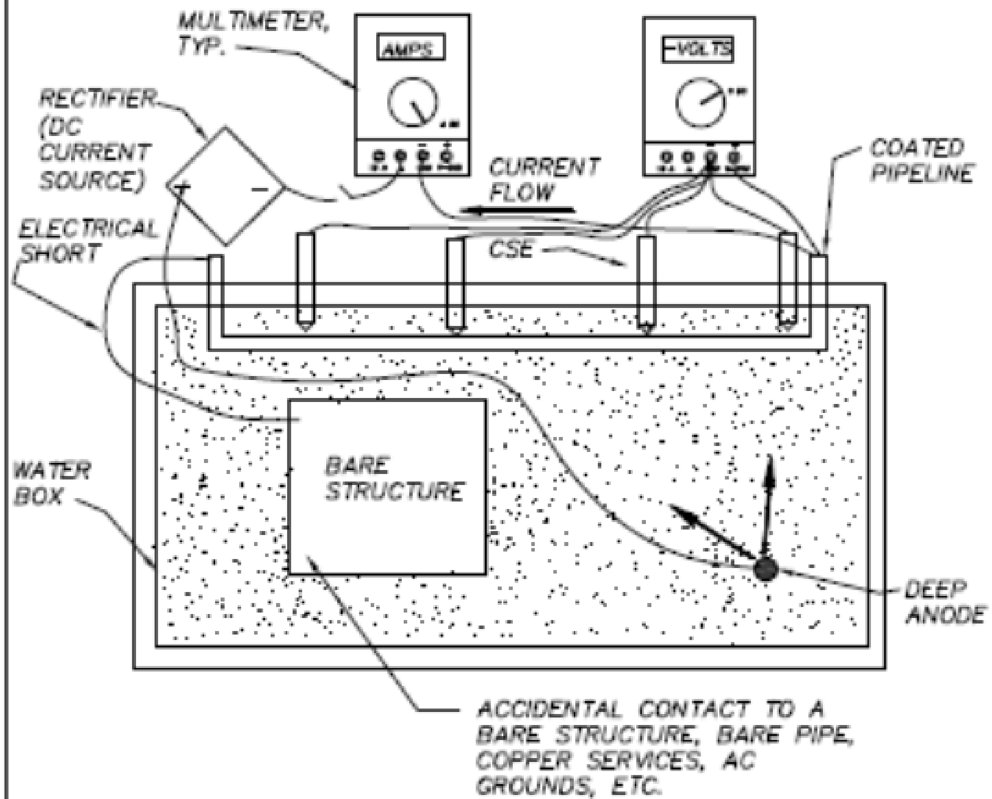
DETAIL W-15B

W-15B Pipeline Current Flow



DEMONSTRATION: The influence of a bare structure or copper service short to a pipeline is shown.



QUESTIONS

16a. What influence does an electrical short to a copper service have on pipeline corrosion rate?

16b. What influence on the cathodic protection potentials?

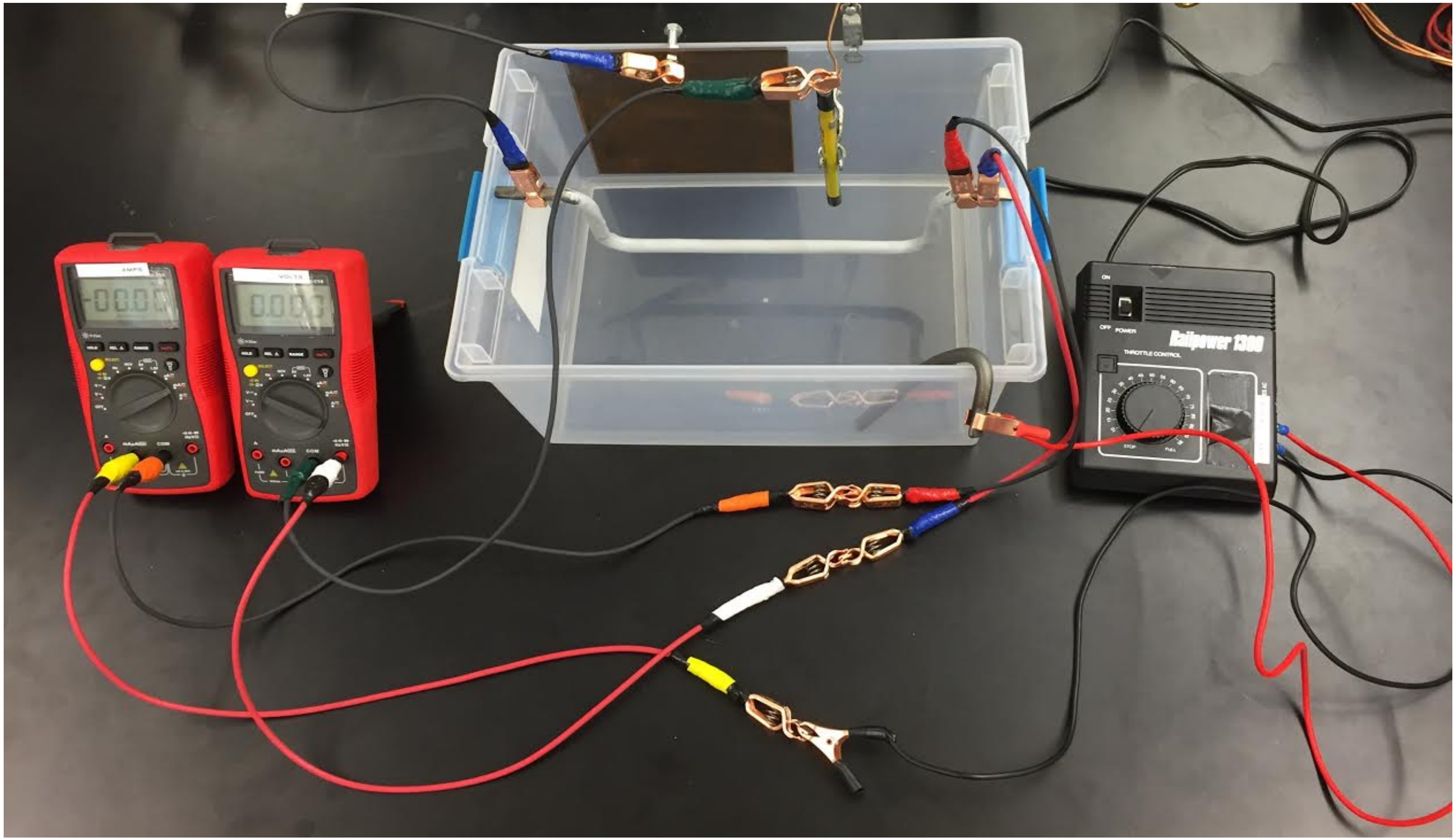
16c. What influence on the cathodic protection current requirement?

INFLUENCE OF SHORTS

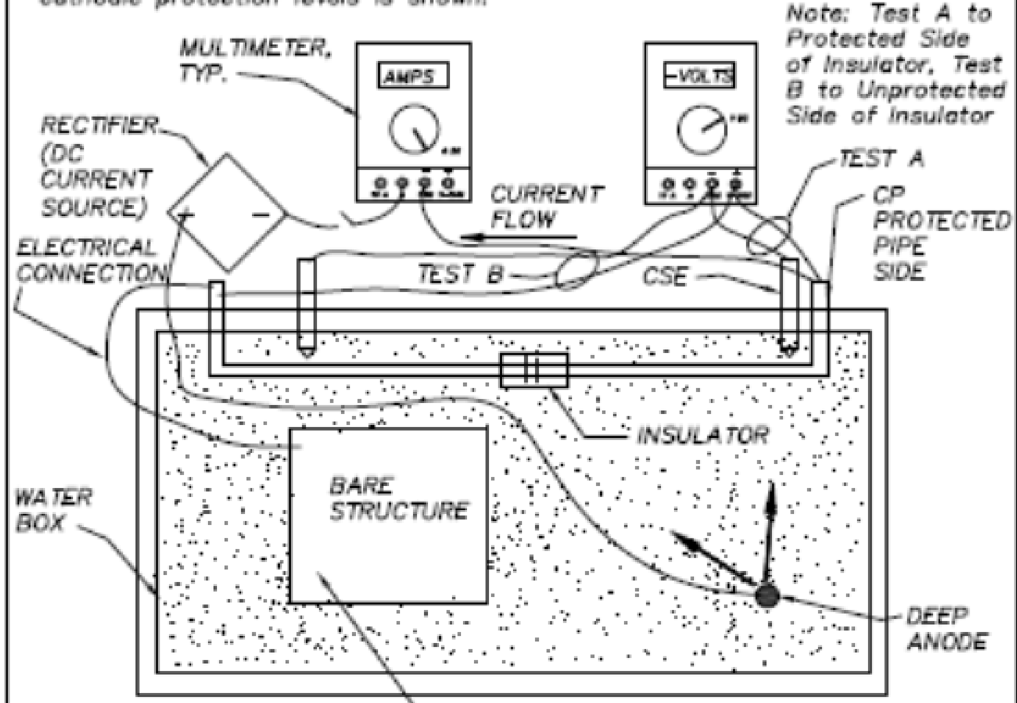
NTS

DETAIL W-16

W-16 Influence of Shorts



DEMONSTRATION: The influence of electrical insulators on a pipeline cathodic protection levels is shown.



QUESTIONS

16Aa. What are some methods to test if an buried electrical insulator is good or not?

16Ab How does an electrical insulator on the pipeline influence the cathodic protected pipeline protection levels? Cathodic protection current requirements"

16Ac. Is the pipeline protected on both sides of a good insulator?

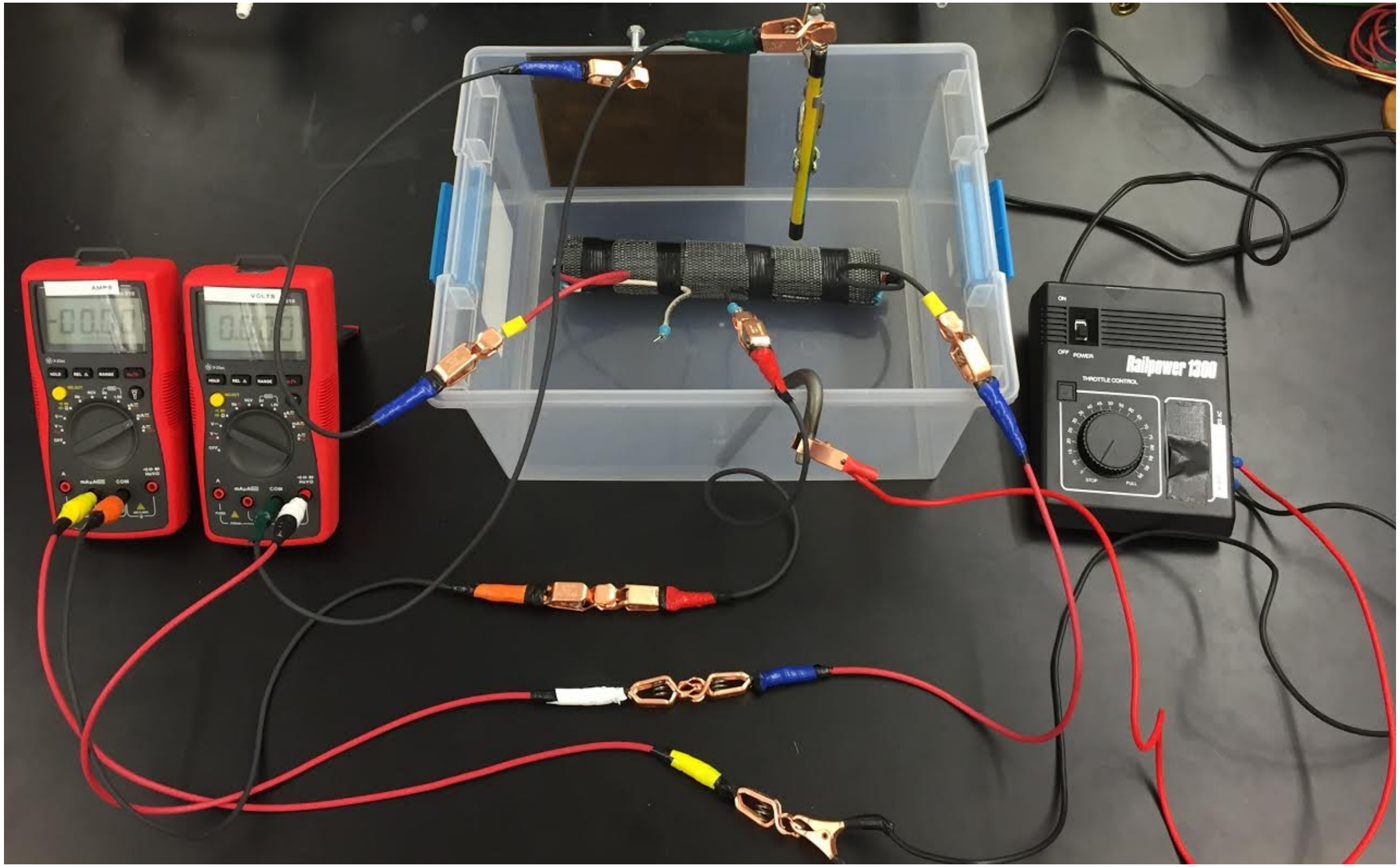
16Ad. What happens if the electrical insulator becomes shorted?

PIPELINE ELECTRICAL INSULATORS

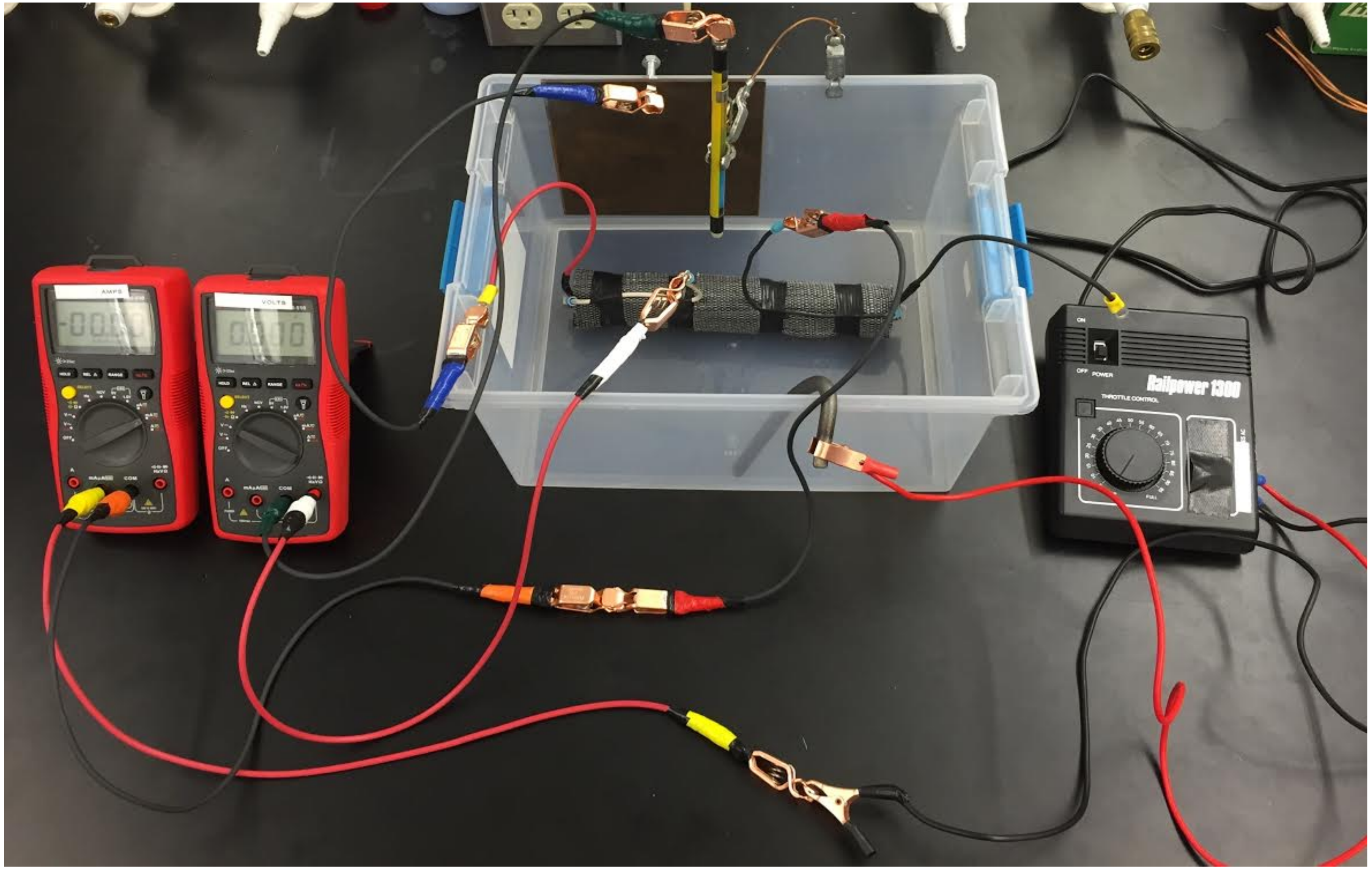
NTS

DETAIL W-16A

W-16A Pipeline Insulators Test A Part 1



W-16A Pipeline Insulators Test B Part 1



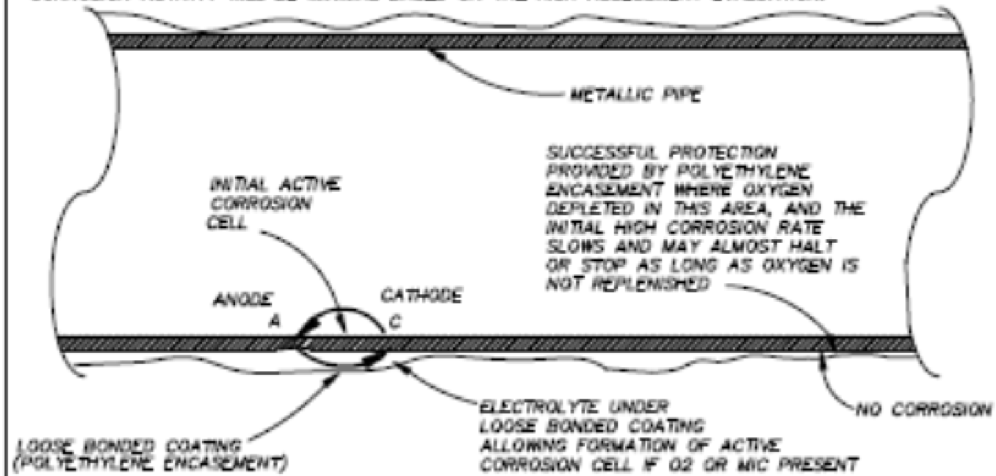
GENERAL POLYETHYLENE ENCASEMENT DESIGN CONSIDERATIONS:

1. POLYETHYLENE IS A PASSIVE TYPE PROTECTION SYSTEM, SO ANY DAMAGE TO POLYETHYLENE ENCASEMENT WILL ALLOW CORROSION TO OCCUR AT SAME RATE AS IF FOR BARE METAL.

2. EVALUATE THE CORROSIVE CONDITIONS (RISK ASSESSMENT) AND PRESENCE OF CHANCE OF MICROBIOLOGICAL INDUCED CORROSION (MIC) ACTIVITY PRIOR TO SELECTION OF POLYETHYLENE ENCASEMENT FOR CORROSION CONTROL.

3. IF THE RISK ASSESSMENT INDICATES THAT THE SOILS ARE NOT TOO CORROSIVE DEPENDING ON DESIRED DESIGN LIFE AND PIPE RELIABILITY, THEN POLYETHYLENE ENCASEMENT MAY BE THE APPROPRIATE LEVEL OF CORROSION PROTECTION REQUIRED.

4. IF THE RISK ASSESSMENT INDICATES THAT THE SOILS ARE MEDIUM CORROSIVITY DEPENDING ON DESIRED DESIGN LIFE AND PIPE RELIABILITY, THEN POLYETHYLENE ENCASEMENT WITH CATHODIC PROTECTION MAY BE THE APPROPRIATE LEVEL OF CORROSION PROTECTION REQUIRED. THIS ACCEPTS THAT SOME ELECTRICAL SHIELDING OF CATHODIC PROTECTION MAY OCCUR, BUT THAT THE LEVEL OF CORROSION ACTIVITY WILL BE MINIMAL BASED ON THE RISK ASSESSMENT EVALUATION.



POLYETHYLENE ENCASEMENT NOTES:

1. POLYETHYLENE ENCASEMENT CONSISTS OF 4 OR 8-MIL POLYETHYLENE SHEET OR TUBE WRAPPED AROUND PIPE. ALWAYS VERIFY THAT CERTIFIED MATERIAL IS PROVIDED.

2. IT IS PROMOTED AS A PASSIVE CORROSION CONTROL SYSTEM THAT CHANGES ENVIRONMENT AROUND THE PIPE AND DOES NOT OFFER ANY CATHODIC PROTECTION PROPERTIES.

3. ENCASEMENT IS NOT INTENDED TO BE AIR OR WATER TIGHT.

4. THEORETICALLY ENCASEMENT CREATES AN ANAEROBIC CONDITION, WHERE THE INITIAL HIGH CORROSION RATE DECREASES OR STOPS AS THE PRELIMINARY HIGH OXYGEN CONTENT IS DEPLETED.

5. INTACT CONDITION OF POLYETHYLENE ENCASEMENT IS ESSENTIAL AS CORROSION WILL OCCUR AT BARE OR TORN ENCASEMENT LOCATIONS AT SAME RATE AS FOR BARE METAL.

5. DO NOT ALLOW SOIL OR CONTAMINATES TO BE TRAPPED UNDER POLYETHYLENE ENCASEMENT AS A CORROSION CELL MAY OCCUR UNDER THE POLYETHYLENE ENCASEMENT.

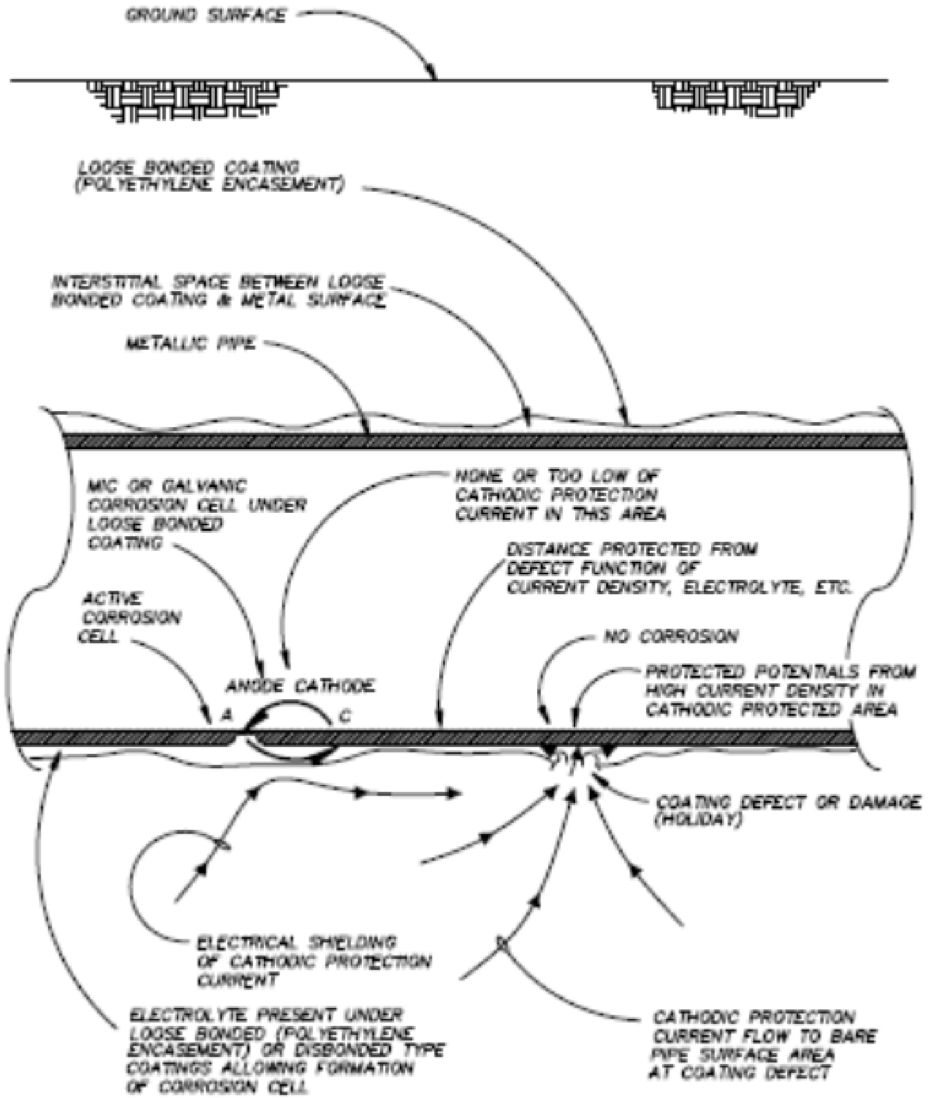
6. UTILIZE TUBE TYPE ENCASEMENT AND SEAL THE POLYETHYLENE ENCASEMENT AT EACH JOINT AND AT TWO FOOT INTERVALS TO MINIMIZE MIGRATION OF WATER AND OXYGEN UNDERNEATH THE POLYETHYLENE ENCASEMENT.

7. ALWAYS REPAIR ANY DAMAGE TO THE POLYETHYLENE ENCASEMENT.

THEORY OF POLYETHYLENE ENCASEMENT

NTS

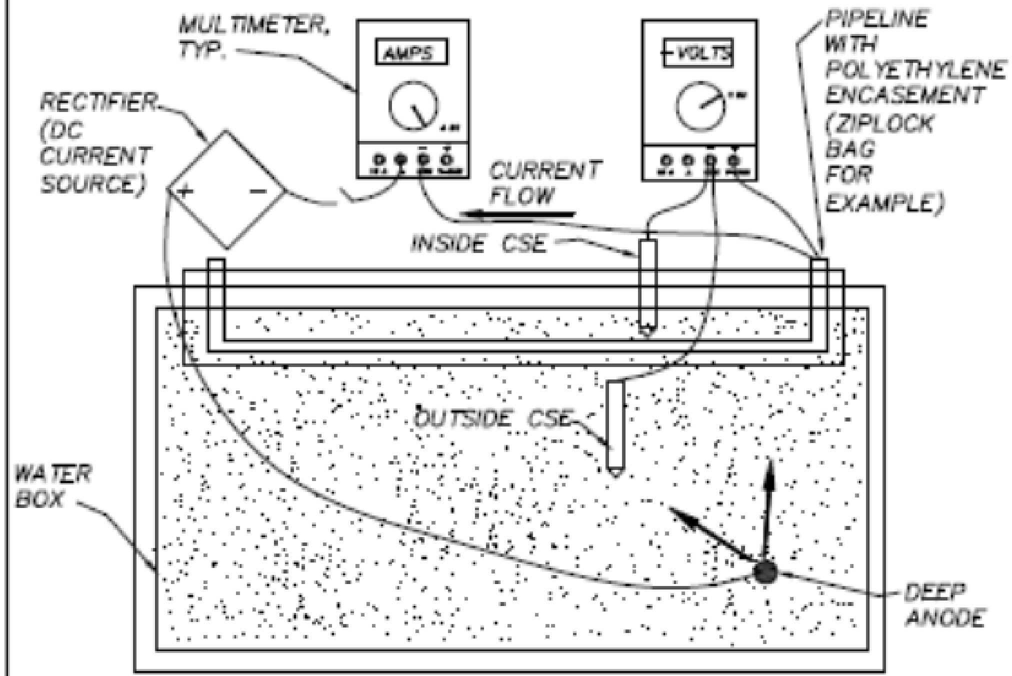
FIGURE W-17



CATHODIC PROTECTION
ELECTRICAL SHIELDING CONCERNS
WITH POLYETHYLENE ENCASEMENT
(LOOSE) OR DISBONDED COATINGS

FIGURE W-17A

DEMONSTRATION: Polyethylene encasement with and without CP on a pipeline is shown.



QUESTIONS

17a. What is the theory of protection with polyethylene encasement?

17b. What happens if the oxygen is replenished?

17c. What is the potential difference inside and outside undamaged polyethylene encasement?

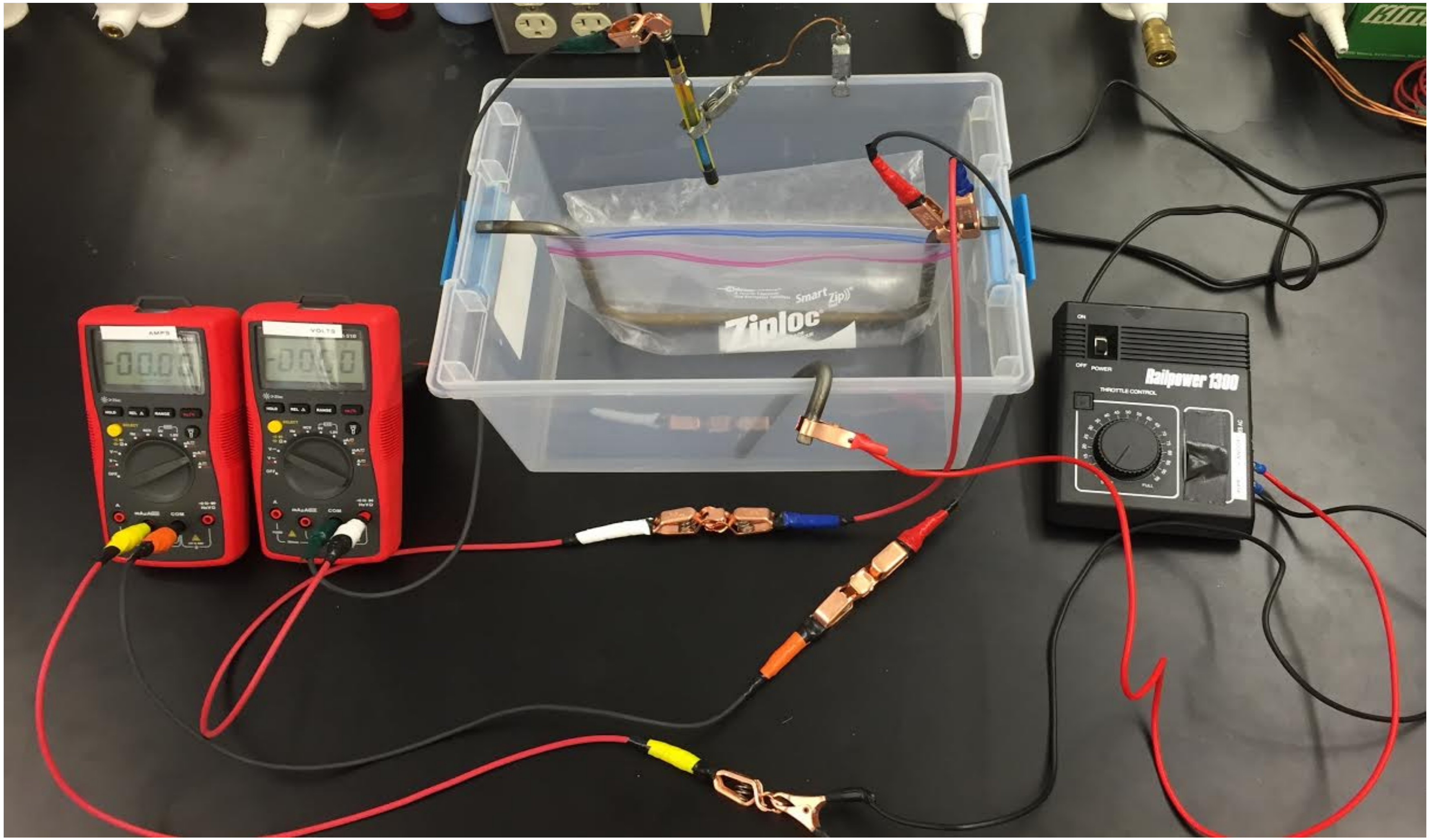
17d. What happens to the inside and outside potential differences as the polyethylene encasement becomes more damaged or more penetrations are provided?

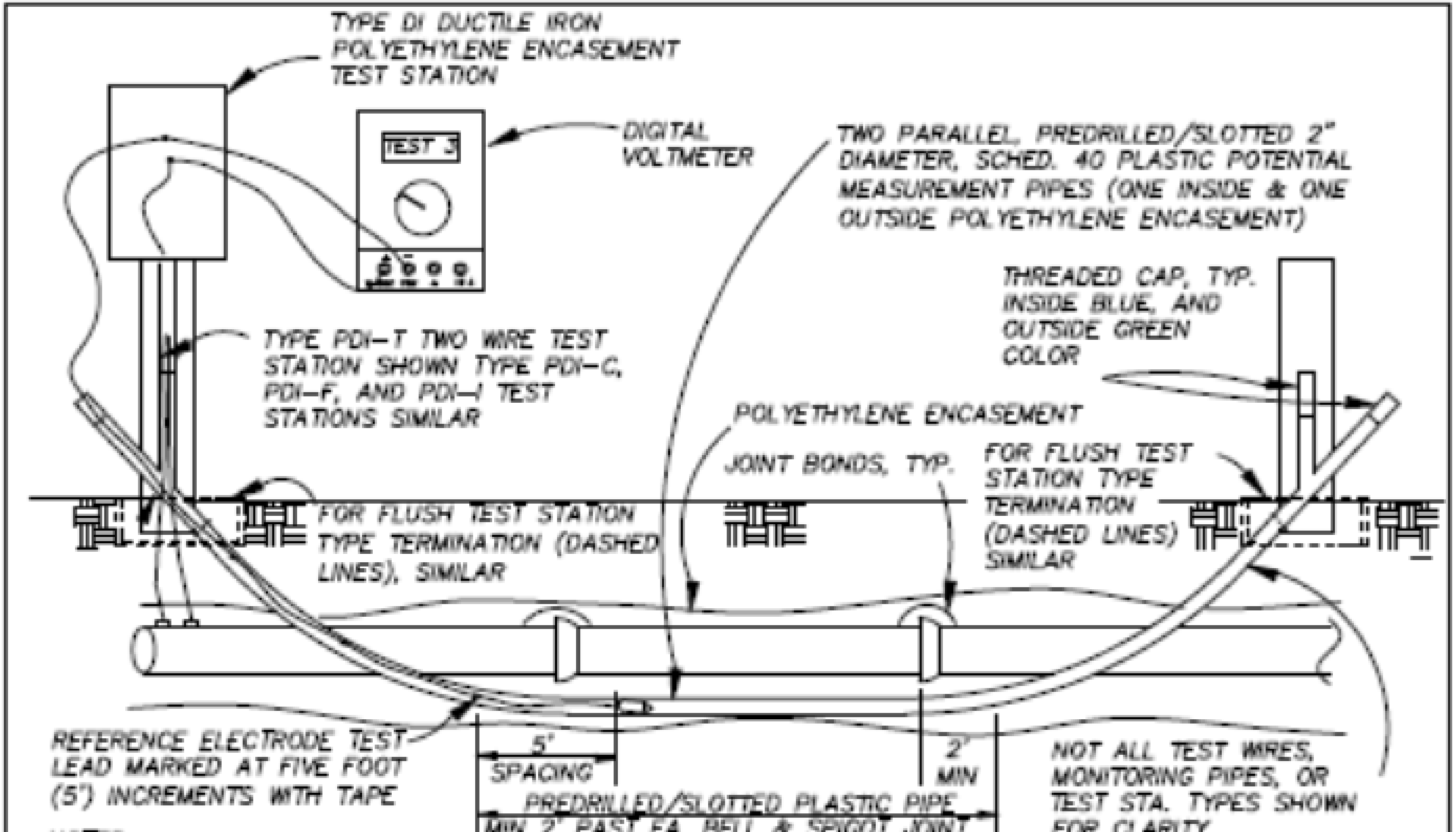
POLYETHYLENE ENCASEMENT

NTS

DETAIL W-17B

W-17B Polyethylene Encasement or Disbonded Coating Electrical Shielding





NOTES:

1) SET THE MULTIMETER TO THE 20 VOLT DC SCALE AND CONDUCT MEASUREMENTS WITH PORTABLE REFERENCE INSERTED IN BOTH INSIDE AND OUTSIDE PLASTIC MONITORING PIPE SIMILAR TO PREVIOUS POTENTIAL MEASUREMENTS DIRECTLY TO SOIL OR TO BURIED REFERENCE ELECRODE.

2) INSERT PORTABLE REFERENCE ELECTRODE INTO INSIDE PLASTIC MONITORING PIPE (BLUE TOP). MOVE PORTABLE REFERENCE ELECTRODE AND RECORD MEASUREMENTS AT FIVE FOOT (5') INCREMENTS.

3) CONDUCT MEASUREMENTS FOR ENTIRE LENGTH OF PLASTIC MONITORING PIPE, STARTING FIVE (5') IN.

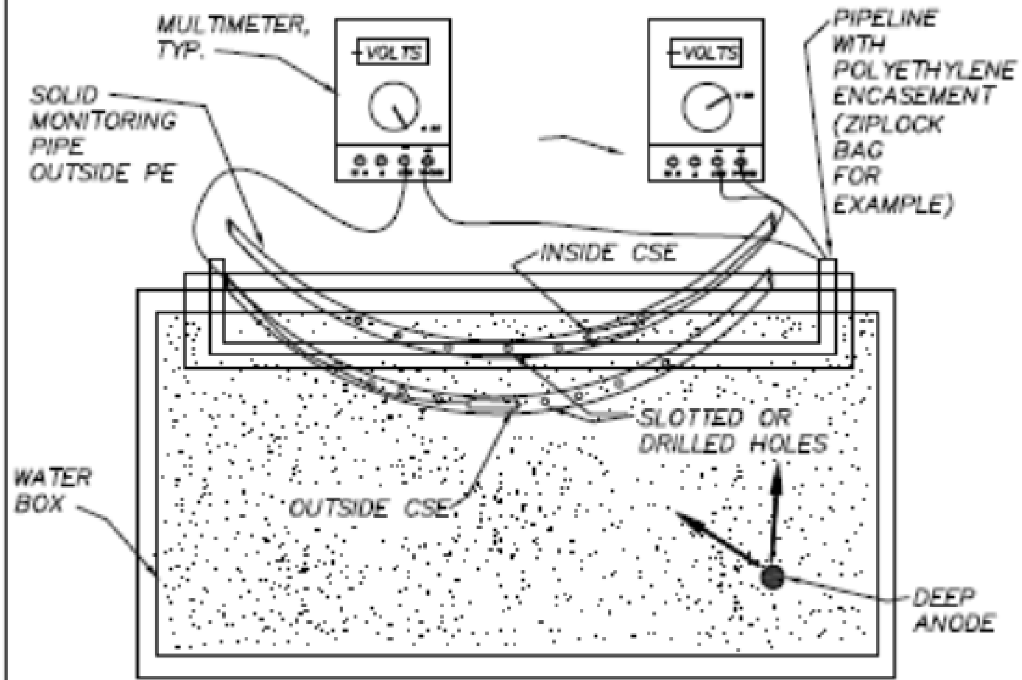
4) REPEAT SAME PROCEDURE FOR PLASTIC MONITORING PIPE LOCATED OUTSIDE POLYETHYLENE ENCASEMENT (GREEN TOP) FOR COMPARISON TO INSIDE PLASTIC PIPE (BLUE TOP) POTENTIAL MEASUREMENTS.

POTENTIALS W/ TYPE PDI STATIONS

NTS

DETAIL W–17C

DEMONSTRATION: Polyethylene encasement with plastic monitoring pipes inside and outside of the encasement is shown.



QUESTIONS

17a. How does the plastic monitoring pipe work with polyethylene encasement? Why is it slotted or drilled?

17b. How do you help assure good electrical contact with the reference electrode?

17c. Which potential inside or outside most accurately reflects the potential at the pipeline surface?

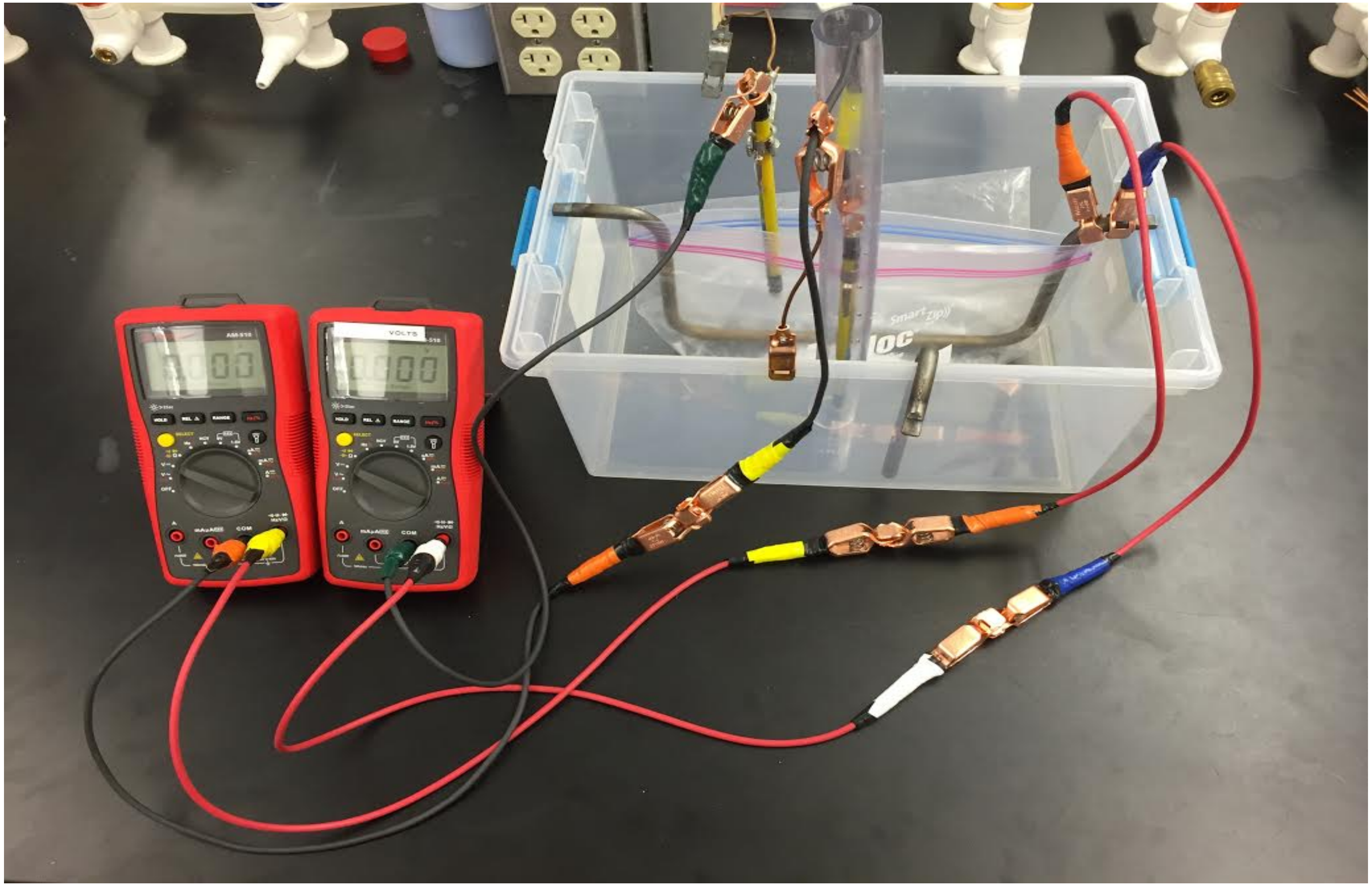
17d. Which potential is usually more negative? Possible reasons for this?

POLYETHYLENE ENCASEMENT PLASTIC MONITORING PIPES

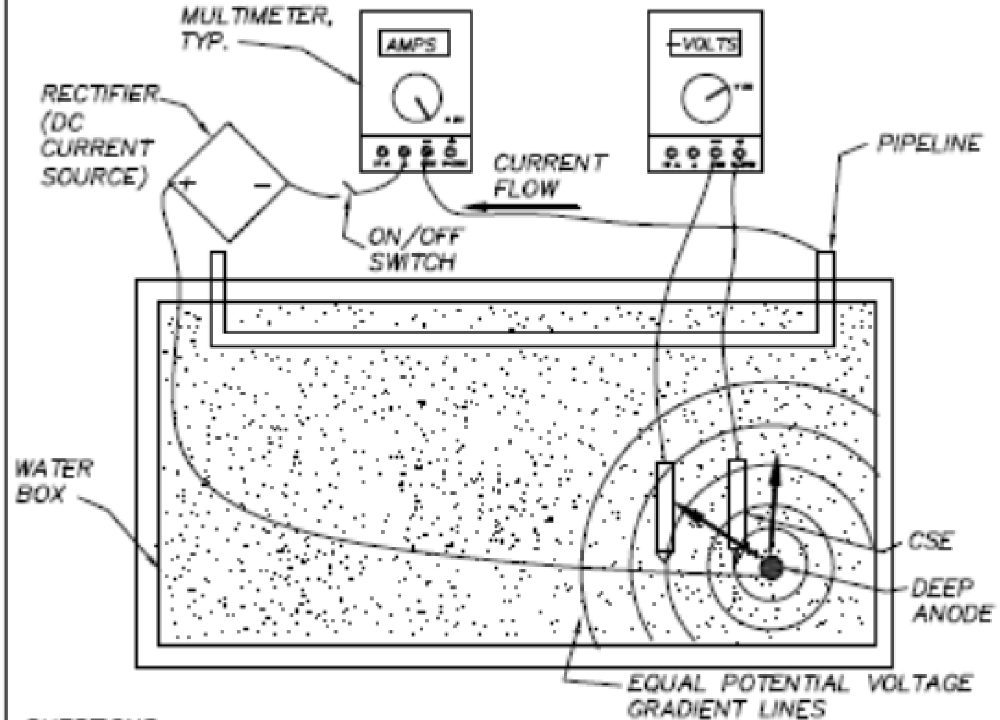
NTS

DETAIL W-17D

W-17 C & D Potential Measurements With Polyethylene Encasement



DEMONSTRATION: The effect of the voltage gradient around a groundbed is shown.



QUESTIONS

18a. Why is there a voltage gradient around the groundbed?

18b. What is density of the voltage gradient equal potential lines near the anode?

18c. What influence does soil resistivity have on the voltage gradient? Current output?

18d. If the pipeline is too close to the groundbed voltage gradient, what detrimental influence may the voltage gradient have on the pipeline?

GROUNDBED VOLTAGE GRADIENT

NTS

DETAIL W-18

W-18 Groundbed Voltage Gradient