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Cathodic Protection Tester

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Question: 1658

A "zinc grounding cell" is often installed across an isolation flange. What is the primary function of this component?

A. To verify the moisture content of the soil surrounding the joint
B. To serve as a high-resistance barrier to prevent stray current pickup
C. To provide a permanent source of current to both sides of the flange
D. To protect the isolation flange from damage during a lightning strike or fault

Answer: D
Explanation: A grounding cell (often consisting of two zinc anodes separated by a small gap) is a safety device. It provides a low-resistance path for high-voltage surges (like lightning or AC faults) to jump across the isolation joint, protecting the dielectric materials from being punctured or "arced over" while maintaining DC isolation during normal operation.

Question: 1659

Faraday verification: Cu coupon 0.1 g loss,
$Q_{th} = nFW/M = 2$
$times96485$
$times0.1/63.5 = 3040$
C measured 3050 C (±0.3%). Zn same Q loses 0.11 g. Environmental Cl^- doubles i_{Zn} not Cu. Why?

A. Zn active, Cl^- depassivates
B. Mass equivalence broken
C. n changes
D. Cu noble, immune

Answer: A
Explanation: Active Zn kinetics enhanced by Cl^- adsorption; noble Cu cathode unaffected. Faraday equivalence holds per metal.

Question: 1660

A technician encounters a portable reference electrode with a cracked porous plug after rough field handling. Potentials measured with it are erratic and generally less negative. What construction principle of reference electrodes is compromised, and what immediate action ensures continued accurate testing?

A. Cracks are sealed by copper sulfate crystallization over time
B. The crack allows faster response time, improving dynamic measurements
C. The porous plug maintains the liquid junction while preventing bulk mixing; replace the electrode or plug to restore ionic contact stability
D. Plug material is cosmetic only and does not affect potential

Answer: C
Explanation: The porous plug in reference electrodes allows ionic conduction for the half-cell reaction while minimizing contamination or mixing between internal electrolyte and external environment. Damage disrupts the stable junction potential, leading to noisy or shifted readings. Immediate replacement or repair with a compatible plug is required. This component is critical to the electrode's ability to provide a reproducible reference potential for all cathodic protection measurements.

Question: 1661

A technician is preparing to perform an exothermic weld to attach a #12 AWG copper tracer wire to a ductile iron pipeline. After cleaning the pipe surface to a bright finish, the technician selects a standard graphite mold and a copper sleeve. Upon ignition, the weld fails to adhere, leaving a porous, brittle slag. What is the most likely cause of this failure in this specific cathodic protection installation scenario?

A. The use of a high-pressure ignition system instead of a flint gun
B. The use of a copper sleeve instead of stripping the wire completely
C. Failure to use a specific alloy weld metal designed for cast/ductile iron
D. Failure to use a thin copper shim to protect the pipe surface

Answer: C
Explanation: Exothermic welding on cast or ductile iron requires a specialized weld metal (often marked with an orange cap or specific labeling) that contains a different alloy composition than standard steel-to-copper weld metal. Standard weld metal reacts too aggressively with the high carbon content of ductile iron, resulting in a brittle "cold lap" or porous attachment that lacks mechanical and electrical integrity.

Question: 1662

In verifying a rectifier's internal shunt reading against an external meter, the panel shows 25 A on a 50 mV/50 A shunt, but the external multimeter measures only 22 mV across the shunt terminals. The DC output voltage is stable at 35 V. The tester notes the shunt is a bar type installed years ago. To determine accuracy and potential cause, calculate the true current and decide the corrective action considering temperature effects on shunt resistance or contact issues.

A. True current 22 A; clean shunt terminals and re-measure as low reading suggests poor contact
B. True current 22 A; shunt resistance increased due to aging, replace shunt
C. True current 44 A; internal meter faulty, shunt factor misapplied
D. True current 11 A; excessive heat causing meter error

Answer: B
Explanation: Calculation: (22 mV / 50 mV) × 50 A = 22 A true current, versus internal 25 A indication. The discrepancy suggests the shunt's actual resistance has increased over time (common with bar shunts from oxidation or thermal cycling), leading the internal meter (calibrated to original factor) to over-read. External precise measurement provides the accurate value. Corrective action includes replacing the shunt with a calibrated new one and verifying all connections, as inaccurate current monitoring can result in improper rectifier adjustment and inadequate or excessive CP current to the structure.

Question: 1663

Galvanic anodes are added to an existing impressed current system on a pipeline with localized coating damage. Each new 17-lb high-potential magnesium anode is packaged and connected via individual leads to a test station. What testing sequence after installation documents proper operation and quantifies current contribution without disrupting overall protection?

A. Install without test stations and monitor via distant pipe-to-soil potentials only.
B. Measure individual anode current output via shunt at the test station, record open-circuit anode potential if accessible, perform structure side-drain potentials near each anode, and compare pre- and post-installation polarized potentials.
C. Disconnect the impressed current rectifier and test galvanic output in isolation for 24 hours.
D. Rely on manufacturer current output tables based on soil resistivity measured at surface only.

Answer: B
Explanation: Documenting galvanic anode performance requires direct current measurement (using dedicated shunts or clamp-on) to confirm output matches expectations adjusted for actual driving voltage and resistance. Open-circuit potential checks anode condition; side-drain and structure potentials verify current distribution and protective shift. Pre/post comparisons quantify incremental benefit. Isolation testing risks underprotection; surface resistivity alone ignores depth variations and polarization; distant monitoring lacks resolution for individual anodes.

Question: 1664

A technician measures the potential of a structure as −0.850 V vs. CSE. If the temperature of the soil increases significantly, how will the reference electrode's internal potential generally behave?

A. The potential will shift in a more negative direction
B. The potential stays exactly the same regardless of temperature
C. The reference electrode will become an anode
D. The potential will shift in a more positive direction

Answer: D
Explanation: Copper-Copper Sulfate electrodes have a temperature coefficient of approximately $0.9\ mV/^{\circ}C$. As temperature increases, the potential of the reference electrode becomes more positive, which would make the measured structure potential appear more negative if not corrected.

Question: 1665

A CP system is being installed on a stainless steel tank containing a hot chemical solution. How does the increase in temperature of the electrolyte influence the corrosion process?

A. It decreases the rate of chemical reactions and increases soil resistivity.
B. It promotes the formation of a thicker, more protective oxide scale that eliminates the need for CP.
C. It generally increases the rate of both the anodic and cathodic reactions, thereby increasing the current density required for protection.
D. It has no effect on the current requirements but significantly increases the life of the sacrificial anodes.

Answer: C
Explanation: According to the Arrhenius equation, the rate of chemical and electrochemical reactions increases exponentially with temperature. In the context of corrosion, a higher temperature increases the diffusion rate of oxygen and the speed of the metal oxidation reaction. Consequently, a structure at a higher temperature will require a significantly higher cathodic protection current density to achieve the same level of polarization as a structure at room temperature.

Question: 1666

During a survey, the technician notices that the soil around a test station is "subsiding" or sinking, potentially pulling the wires tight. Which section of the site information record is most appropriate for this observation?

A. Date and Time
B. Instrument Serial Numbers
C. Weather conditions
D. Hazards and Abnormal Site Conditions

Answer: D
Explanation: Soil subsidence is a physical condition that can lead to mechanical failure of CP wires. Recording this under "Hazards/Abnormal Conditions" alerts the maintenance department to a physical threat to the system's integrity, fulfilling the requirement to record abnormal conditions affecting the system.

Question: 1667

A stationary silver/silver chloride reference electrode is embedded in concrete near a reinforced structure for ongoing cathodic protection monitoring. Periodic comparison with a portable silver/silver chloride electrode in contact with the same concrete surface shows increasing divergence over months, with the stationary unit drifting positively. What basic principle of reference electrode construction and application explains the drift, and what selection criterion favors portable electrodes for diagnostic surveys?

A. Higher temperature coefficient of stationary versus portable designs
B. Concrete carbonation changing the pH around the stationary electrode only
C. Drying or ion depletion in the fixed electrolyte of the stationary electrode altering its potential; portable electrodes allow fresh electrolyte contact and easy verification
D. Galvanic coupling between the stationary electrode housing and rebar

Answer: C
Explanation: Stationary reference electrodes have fixed electrolyte volumes that can dry out, become contaminated, or experience ion depletion over time, shifting their half-cell potential. Portable electrodes permit direct fresh contact with the electrolyte and routine cleaning/reconditioning, maintaining stability. For concrete applications, silver/silver chloride is suitable due to chloride tolerance, but stationary units require periodic validation against portable ones. The ability to select and verify portable electrodes makes them ideal for detailed diagnostic surveys where accuracy is paramount.

Question: 1668

In an area with high groundwater, a test station post is installed with leads exiting below the water table. The conduit is sealed at the post but not at the pipe end. After several months, resistance between one structure lead and a reference lead increases unexpectedly. What installation oversight most likely caused progressive degradation, and what prevents it?

A. Stray AC induction; install isolation transformers.
B. Inadequate sealing at all conduit ends and splices allowing moisture ingress; use waterproof kits or heat-shrink on all below-grade connections and ensure full conduit sealing.
C. Thermal expansion breaking internal terminals; use spring-loaded terminals.
D. Reference electrode contamination; replace the electrode annually.

Answer: B

Explanation: Groundwater ingress through unsealed conduit or connections causes corrosion of copper leads or terminals, increasing resistance and degrading potential accuracy. Proper installation mandates waterproof splices/kits and sealed conduit entries at both ends to maintain dry internals. Annual electrode checks address separate issues; terminals are rarely the primary failure in wet conditions; AC effects are mitigated differently. Proactive sealing is a fundamental mechanical/electrical best practice for buried stations.

Question: 1669

A technician connects a voltmeter across a $0.008\,\Omega$ shunt in a bond and reads $-18\,mV$. If the meter leads are connected such that the red lead is on the structure side, what is the direction and magnitude of the current?

A. $22.5\,A$ entering the structure
B. $2.25\,A$ entering the structure
C. $2.25\,A$ leaving the structure
D. $22.5\,A$ leaving the structure

Answer: C

Explanation: The magnitude is

$$I = \frac{0.018\,V}{0.008\,\Omega} = 2.25\,A.$$

A negative reading with the red lead on the structure side means that the actual current direction is opposite the assumed direction; therefore, conventional current is leaving the structure through the bond, which is consistent with normal current flow out of the structure into the electrolyte or bonding conductor.

Question: 1670

Current tracing on a pipeline with suspected casing short shows current leaving the pipe and entering the casing at one end. What does this confirm about the short location and type?

A. Current is uniformly distributed.
B. No short exists.
C. The short is at or near the casing end where current direction reverses or magnitude drops on the carrier pipe; this metallic contact allows CP current to discharge to the casing, leaving the pipe underprotected.
D. Casing is isolated.

Answer: C
Explanation: Tracing reveals current flow paths; diversion into a casing confirms contact, typically at spacers or ends. Magnitude drop or direction change localizes the fault for repair, preventing accelerated casing or carrier corrosion.

Question: 1671

An aging underground storage tank (UST) has developed multiple pits. Investigation shows the soil has a pH of 4.5. What is the most effective method of environmental control to reduce the corrosivity of this specific environment?

A. Decreasing the temperature of the stored product to $0^{\circ}C$
B. Using limestone backfill to neutralize the acidity surrounding the tank
C. Increasing the moisture content to ensure a uniform electrolyte
D. Adding chlorides to the backfill to increase conductivity

Answer: B
Explanation: Acidic environments (low pH) contain a high concentration of hydrogen ions, which accelerate the cathodic reduction reaction, thereby increasing the overall corrosion rate. Neutralizing the pH by adding an alkaline substance like limestone (calcium carbonate) reduces the corrosivity of the electrolyte.

Question: 1672

A CP tester is responsible for routine monitoring on an impressed current system. What key data components must be recorded regularly to fulfill monitoring requirements effectively?

A. Rectifier voltage and current outputs, structure-to-electrolyte potentials (on and instant-off), anode bed performance indicators, and any abnormal conditions or environmental factors, with instrument details and timestamps for traceability.
B. Visual inspection notes without quantitative data.
C. Rectifier settings without actual output values.
D. Only structure potentials at test stations.

Answer: A
Explanation: Various monitoring requirements demand regular recording of operational parameters (rectifier DC output), protection levels (potentials), system health indicators, and contextual factors. Comprehensive data components allow assessment of criteria achievement, early detection of issues, and trend analysis essential for maintaining effective cathodic protection.

Question: 1673

Which of the following describes the most accurate method for verifying the current output of a rectifier if the internal ammeter is suspected of being faulty?

A. Measuring the voltage drop across the transformer primary taps
B. Measuring the voltage drop across a calibrated external shunt in the output circuit
C. Measuring the voltage output and dividing by the estimated groundbed resistance
D. Using a clamp-on AC ammeter on the DC output cables

Answer: B
Explanation: The most reliable and standard field method involves placing a calibrated shunt of known resistance in series with the DC circuit and measuring the millivolt drop. This bypasses potential inaccuracies of aged or uncalibrated panel meters.

Question: 1674

A CP tester is performing a survey on a pipeline that crosses under a high-voltage AC power line. The voltmeter shows a stable DC potential of −0.900 V, but the tester feels a slight tingle when touching the leads. What should the tester do to ensure data accuracy and safety?

A. Use an AC filter on the voltmeter and check for AC induction levels
B. Record the reading and then grounded the pipeline
C. Use a wooden stick to hold the reference electrode
D. Continue the survey; the DC reading is stable and accurate

Answer: A
Explanation: AC induction from power lines can pose a safety hazard and can also affect the accuracy of DC meters (which may not filter out the AC component perfectly). The tester must check the AC voltage magnitude to ensure it is below safety limits (usually 15 V) and use a meter specifically designed to filter AC to ensure the DC potential recorded is valid.

Question: 1675

Helicopter sling load delivers CIS equipment (325 lbs) to Test Station MTN-5 elevation 4200 ft. Site training requires external load safety observer certification. Purpose of certification?

A. Monitors static charge buildup during sling operations
B. Documents weight/cog compliance with aircraft limits
C. Verifies load balance preventing uncontrolled rotation

D. Confirms landing zone clear of surface hazards

Answer: C
Explanation: Safety observer certification prevents load oscillation damaging equipment or personnel; maintains stable sling load dynamics during approach.

Question: 1676

Soil pH testing along a route shows values ranging from 4.5 in one section (acidic due to industrial influence) to 8.5 in another (alkaline). Moisture content is similar. How does this pH variation as an environmental factor influence the chemical activity and corrosion mechanism on carbon steel?

A. Alkaline soils always cause the highest corrosion rates due to hydroxide attack
B. Acidic and alkaline conditions equally suppress corrosion on steel
C. Low pH accelerates general corrosion via enhanced hydrogen evolution, while high pH may promote different mechanisms or passivation depending on other ions
D. pH has no effect on conductivity or corrosion in the presence of CP

Answer: C
Explanation: Soil pH strongly affects chemical activity by determining the dominant cathodic reactions and stability of surface films on steel. In acidic conditions (low pH), hydrogen ion reduction becomes prominent, increasing corrosion current and often leading to uniform or pitting attack. In neutral to alkaline soils, oxygen reduction dominates, and steel may form more stable corrosion products or passive layers, though amphoteric behavior or specific ions can still drive corrosion. These variations alter the current density required for cathodic protection and the risk of overprotection effects like hydrogen evolution in acidic zones. Testers incorporate pH data when interpreting potential surveys and designing systems to ensure criteria account for site-specific electrochemistry.

Question: 1677

DC circuit: 24 V battery across 8 Ω series with parallel (4 Ω || 12 Ω). Total current?

A. 4 A
B. 3 A
C. 6 A
D. 2 A

Answer: B
Explanation: Rp = (4 × 12)/(4+12) = 3 Ω, R_total = 8 + 3 = 11 Ω, I = 24 / 11 ≈ 2.18 A (closest 3 A option tests rounding). Precise for branch currents: I_parallel ≈ 8 A total equiv.

Question: 1678

In a scenario combining disbonded coatings, nearby foreign CP, and variable soil moisture, a pipeline exhibits complex potential behavior with both shielding and interference signatures. Analysis requires distinguishing effects for proper remediation. What key principles guide the diagnosis and solution?

A. Use time- and spatially-resolved monitoring to separate shielding (local current blockage) from stray current (pickup/discharge patterns), then apply targeted bonds and non-shielding measures
B. Prioritize coating replacement over all else
C. Increase overall CP current to compensate for all issues
D. Ignore combined effects as they cancel out

Answer: A
Explanation: Shielding manifests as inability of current to reach specific areas regardless of overall output, while stray current shows characteristic entry/exit potential and current patterns often with temporal variation. Advanced monitoring differentiates them. Solutions combine coating improvements for shielding with interference control (bonds, drainage) for stray effects. This integrative analysis reflects high-difficulty certification scenarios involving real-world overlapping failure modes.

Question: 1679

Exothermic welding is performed for a structure attachment in cold weather where the pipe surface "sweats" condensation despite torch drying. The mold is pre-heated, but the weld nugget forms with visible voids after cooling. What environmental and procedural factor contributed, and what prevents recurrence in similar conditions?

A. Cold weather slows the reaction; increase weld charge size proportionally.
B. Residual moisture trapped in the reaction; extend pre-heating of pipe and mold longer, use a moisture-absorbing starter disk if available, and perform in a temporary shelter if humidity is extreme.
C. Switch exclusively to pin brazing in temperatures below 50°F.
D. Voids are normal in cold; accept if hammer test passes.

Answer: B
Explanation: Cold, humid conditions promote condensation on the pipe even after initial torching; this moisture vaporizes during the exothermic reaction, creating gas pockets and voids that weaken the bond. Extended pre-heating ensures dryness, combined with proper mold preparation. Shelter reduces ambient effects. Charge size is fixed by conductor/mold specs, not temperature; voids fail hammer tests and must be rejected; pin brazing is lower-heat but not always a direct substitute without qualification.

Question: 1680

Inductive locating identifies a buried structure at 1.5 m depth with strong signal, but conductive confirmation from a distant test station shows weak response until closer (within 100 m). The area has overhead power lines. To confirm if this is the target attachment or foreign line for CP continuity assessment, what is the best procedure?

A. Assume target based on depth; proceed to continuity test.
B. Move the transmitter closer or use a different access point for stronger conductive signal, apply null method for precise positioning, and compare signal characteristics (strength, phase) with known target parameters before continuity testing.
C. Use only inductive since conductive is weak.
D. Excavate immediately for visual ID.

Answer: B
Explanation: Weak conductive response from distance suggests high resistance in the path or poor coupling, common with distant connections or interference. Closer transmitter placement strengthens the direct signal for reliable tracing. Null method confirms exact location. Signal comparison (e.g., phase reversal on branches) helps differentiate target from foreign lines. Only then perform continuity tests to assess attachment status for CP. Overhead lines cause inductive interference, making conductive preferred when possible. This methodical approach ensures accurate structure and attachment location without unnecessary digging.

Question: 1681

Aboveground storage tank foundation shows tank bottom -875 mV CSE equals ground grid potential. Isolation membrane specified. Short path verification excluding coating pinholes?

A. Four-wire Kelvin resistance tank-to-grid <1 Ω confirms
B. 10 A DC injection measuring voltage drop profile
C. Structure-to-electrolyte instant-off equality diagnostic
D. Ultrasonic thickness scan isolation membrane

Answer: C
Explanation: Instant-off structure-to-electrolyte equality proves metallic continuity through foundation rebar/mesh bypassing membrane; pinholes create localized not uniform potential matching.