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Question: 1437

Safety-related coatings must remain effective after a design basis fire event. Which test or criterion best evaluates this according to EPRI guidelines?
A. ASTM D5163 adhesion test after thermal aging at rated temperatures
B. Visual inspection for discoloration only
C. Smoke toxicity and flammability testing under ASTM E162 and ASTM E662
D. Chemical resistance to inorganic acids

Answer: C

Explanation: Fire safety evaluation includes smoke toxicity and flammability per ASTM E162 and E662 to ensure coatings do not contribute to fire hazards, essential under design basis fire conditions. Adhesion and aging tests are important but secondary to fire safety.

Question: 1438

High-complexity: Nuclear shield wall steel to SSPC-SP 10, D4417 2.5 mils; D4228 demo with 10% overspray. Formula for efficiency = (applied volume / total sprayed) x100 >90%. Mitigations?

A. Adjust gun distance to 12 inches, re-measure efficiency
B. Peak density 220 peaks/inch^2 min
C. Bake panels at 200°F for 1 hour post-apply
D. Oil extraction per D7393 on abrasive <50 mg/kg

Answer: A, D

Explanation: Distance adjustment boosts transfer efficiency per D4228. Oil limit per D7393 prevents defects in shields.

Question: 1439

At a BWR Mark I containment during a 2024 steam dryer replacement outage, the inspector assesses a degraded vinyl ester coating on the torus suppression pool baffle after exposure to two-phase flow at 120°C and 0.3 MPa, revealing intercoat delamination per ASTM D5179 tape test rated 1. Holiday testing shows 15 defects/m^2. Using the delamination propagation model $\delta = \sigma \times t \times (1 - \nu) / E$, where σ=stress 20 MPa, t=thickness 15 mils, ν=Poisson 0.35, E=modulus 3 GPa, compute δ=0.08 mm. Identify all mandatory repair sequences and quality control metrics per ANSI/ANS-56.8 for hydrodynamic loading resistance.

A. Remove delaminated areas via needle gun to Sa 2.5 per ISO 8501-1, then spot-repair with 100% solids epoxy at 10 mils DFT, curing via IR lamp at 150°C for 2 hours.

B. Verify repair adhesion with X-cut test per ASTM D3359 Method A, requiring 5B rating, and perform pull-off to 800 psi minimum per ASTM D4541 on 5-grid pattern.
C. Simulate hydrodynamic impulse with water jet at 200 psi, 30° angle, 1 m distance, ensuring no disbondment >2% area per mock-up test per NUREG-0800 Branch 5.2.1.
D. Calculate coating stress under LOCA using finite element analysis (FEA) with ANSYS, inputting Young's E=3 GPa, yield strength 50 MPa, and validate model against strain gauge data at 0.5% strain.

Answer: A, B, C

Explanation: BWR torus baffles endure cyclic two-phase flow inducing shear stresses that propagate delamination in vinyl ester coatings, risking debris in ECCS sumps during accidents. The model predicts 0.08 mm crack growth, nearing critical 0.1 mm threshold, mandating removal to Sa 2.5 for clean substrate, followed by epoxy spot-repair for chemical resistance in wet environment, with IR curing accelerating to outage timeline. Adhesion verification via X-cut (5B no lift-off) and pull-off (800 psi for hydrodynamic durability) ensures repair integrity per ASTM standards. Hydrodynamic simulation with jet testing replicates LOCA bubble collapse forces, limiting disbondment to prevent failure modes in NUREG-reviewed designs. FEA is design-phase tool, not repair QC; strain validation supports but isn't sequential step.

Question: 1440

When transferring qualification data between plants, which ASTM approach ensures applicability regarding substrate composition differences?

A. Assuming all carbon steels behave identically without consideration
B. Evaluation according to ASTM D8104 focusing on substrate metallurgical similarity
C. Matching only the nominal steel thickness value
D. Ignoring substrate differences if coating system is certified elsewhere

Answer: B

Explanation: ASTM D8104 emphasizes assessment of metallurgical and surface compatibility to verify applicability of qualification data, as substrate chemistry can significantly impact coating performance.

Question: 1441

A coating removal process provides a DF of 5 on a radioactive surface. The plant requires minimum DF of 10 for reusable coatings. What is the status of this coating?

A. Coating qualifies as safe for reuse with slight remediation
B. Coating is unqualified due to insufficient removal of contamination
C. Coating can be used for non-safety applications only
D. Coating requires additional radiological monitoring but remains qualified

Answer: B

Explanation: The coating does not meet minimum DF criteria (which is 10) set by the plant for safe reuse; therefore, it is categorized as unqualified for reuse in safety-related applications.

Question: 1442

During application of a CSL I epoxy coating on a containment sump strainer, the applicator must maintain environmental controls per ASTM D4228. In a scenario with ambient conditions of 85°F and 75% RH, which controls and measurements must be implemented to ensure defect-free application?

A. Dew point measurement every 4 hours, maintaining surface temp ≥5°F above dew point
B. Substrate temperature control at 80-100°F, verified with infrared thermometer per ASTM E1862
C. Relative humidity reduction to <60% using dehumidifiers with 500 cfm capacity
D. Airflow monitoring at 50-100 fpm in spray booth, per ANSI Z9.3 ventilation standards

Answer: A, B, D

Explanation: ASTM D4228 mandates environmental controls for CSL I coatings to prevent moisture entrapment. Dew point ≥5°F above surface temp avoids condensation, critical for adhesion in sumps exposed to LOCA sprays. Substrate temp of 80-100°F ensures proper cure kinetics, avoiding amine blush. Airflow at 50-100 fpm removes overspray, maintaining DFT uniformity within ±10% of 10 mils, ensuring strainer integrity.

Question: 1443

Scenario: A PWR enters a 45-day refueling outage (RFO) after 18 months at 95% capacity factor, with reactor coolant system (RCS) drained to mid-loop for inspections. Coatings on the refueling canal exhibit chalking (ASTM D4214 rating 3) due to prior borated water exposure at pH 4.5. Procedure follows NRC Bulletin 89-01 and AMPP SP0892 for nuclear-specific inspections. As the inspector, which complex evaluations and procedural steps must you perform to restore operability before reenabling fuel handling?

A. Quantify chalking extent via ASTM D659-14 surface tension measurement, requiring >30 dynes/cm for rewettability, and apply de minimis criteria per RG 1.82 allowing up to 5% affected area if no loose particles >0.125 inch diameter.
B. Execute a full Qualified/Unqualified Coatings Inventory (QUCI) per EPRI TR-101248, categorizing the system as Safety-Related Coating System (SRCS) and verifying post-repair qualification under LOCA simulation at 315°C/150 psig for 30 days.
C. Perform holiday detection per NACE SP0188 using 30 kV DC pulse on 20 mil DFT, documenting holidays as Coating Degradation Mechanism (CDM) Type 3 (pinholes), and calculate repair epoxy volume: $V = A * t * (1 - p)$, where A=100 m², t=15 mil, p=0.9 porosity.
D. Initiate radiation survey per 10 CFR 20.1501 with smear tests <5000 dpm/100 cm² beta-gamma, followed by surface prep to SSPC-SP 10 near-white metal and recoating with Carboline Carcothane 134

HG polyurethane per manufacturer PDS.

Answer: A, B, D

Explanation: In PWR RFOs, chalking in refueling canals from borated water (pH 4.5, ~2500 ppm B) degrades epoxy integrity, risking particulate release during fuel movement that could clog fuel transfer tubes per NRC Bulletin 89-01. ASTM D659 surface tension measurement assesses cleanability, with de minimis thresholds per RG 1.82 permitting minor defects if particles are controlled to prevent ECCS interference. Q UCI per EPRI ensures SRCS compliance, mandating LOCA qualification to confirm no >1% weight loss or cracking post-exposure, critical for post-outage licensing. Holiday detection per NACE SP0188 identifies voids in 20 mil systems, classifying as CDM to prioritize repairs, though volume calculation aids material planning but isn't a direct procedural step. Radiation surveys per 10 CFR 20 confirm fixability (<5000 dpm limits), enabling SSPC-SP 10 prep (achieving <3% staining) and application of nuclear-qualified polyurethanes like Carcothane 134 HG (per PDS: 4-6 mil DFT, pot life 4 hrs at 70°F), ensuring 99% solids for minimal VOC during confined space work.

Question: 1444

In a nuclear HVAC duct coating (atmospheric, galvanized steel), a single-coat acrylic is proposed. Previous qual on ferritic. DBA test shows 0.18 in. debris in airflow. Calculate duct velocity increase if 10 ducts, 5000 cfm each, debris blocks 5% area. Select requalification.

A. Change to two-coat epoxy/urethane, primer 3 mils, topcoat 4 mils for adhesion to zinc
B. Requalify per ASTM D8104 with galvanized substrate, 1000 h ASTM D2247 humidity; no corrosion >5%
C. Simulate DBA airflow: 50 ft/s, 300°F, 50 Mrad; debris <0.05 in.
D. Update matching to exclude concrete; galvanized system isolated

Answer: A, B

Explanation: Multi-coat required for galvanized adhesion. Humidity test verifies zinc compatibility. DBA airflow prevents loose debris in ventilation.

Question: 1445

A coating system in a nuclear plant exhibits delamination after several thermal cycles involving rapid cooling. Which modification would improve its resistance to such conditions?

A. Incorporation of elastomeric components to enhance flexibility
B. Increasing the coating’s hardness by adding mineral fillers
C. Reducing overall coating thickness to minimize stress accumulation
D. Applying a thin primer layer with high permeability

Answer: A

Explanation: Elastomeric components improve the coating’s flexibility, allowing it to absorb thermal stresses during rapid cooling cycles and prevent delamination. Increasing hardness or reducing thickness alone may not address the flexibility needed, and a high-permeability primer could exacerbate environmental ingress.

Question: 1446

Scenario: HTGR phenolic at 330°F, 10^7 rads, then mixed nuclide decon D4256, 93% for Cs/Co. Use MCNP code for dose simulation, F4 tally for flux. Which inspections?

A. Flux φ <10^{14} n/cm²s equivalent for gamma
B. Nuclide-specific DF >20 via gamma spec
C. Post-decon adhesion pull-off 2,000 psi D4541
D. MCNP variance reduction <5% for accuracy

Answer: B, C, D

Explanation: DF >20 per gamma spec verifies 93% for mixed per D4256. Pull-off 2,000 psi ensures lining post-decon/irradiation. MCNP <5% variance validates simulation tying to D4082.

Question: 1447

In a nuclear coating system failure investigation post-DBA test, which factor would most likely contribute to excessive coating debris formation?

A. Use of topcoat with polyurethane content
B. Excessive coating thickness over 500 microns
C. Use of inorganic zinc primer instead of organic zinc
D. Improper curing leading to weak cohesion between layers

Answer: D

Explanation: Improper curing compromises the bond strength inside and between coating layers, causing them to break apart under thermal and chemical stress, producing debris. Thickness, material choice, and polyurethane content are secondary if curing is deficient.

Question: 1448

In a nuclear facility, a CSL III alkyd coating on auxiliary building piping requires touch-up after mechanical damage. Per SSPC-SP 3 (power tool cleaning), which preparation steps and acceptance criteria must be met for brush-applied repairs?

A. Surface cleaning to St 3, removing all loose rust with 80-grit flap disc at 10,000 rpm

B. Feathering edges to 1:3 taper ratio, verified by caliper measurement per ASTM D4138
C. Post-cleaning solvent wipe with MEK, ensuring <5 μg/cm² residue per ASTM D4262
D. Profile verification at 1-1.5 mils using ASTM D4417 Method B (stylus instrument)

Answer: A, B

Explanation: SSPC-SP 3 for CSL III touch-ups requires St 3 cleanliness, achieved with abrasive discs to remove rust, ensuring adhesion >150 psi for non-critical piping. Feathering at 1:3 blends repair edges, preventing stress risers that could lead to peeling under thermal cycling (50-150°F). These steps align with ASTM D4138 for seamless integration, maintaining corrosion protection without stringent CSL I controls.

Question: 1449

A coating system qualified under ASTM D5144 exhibits a loss in adhesion after chemical exposure per ASTM D3912. What remedial action should be documented before field application?

A. Requalification with revised chemical resistance testing and possible reformulation
B. Acceptance based on radiation resistance alone per ASTM D4082
C. Extending cure times without retesting
D. Substituting chemical testing with accelerated UV exposure tests

Answer: A

Explanation: Loss of adhesion after chemical resistance testing indicates insufficient performance; the system must be requalified possibly with reformulation before plant application to meet nuclear safety standards.

Question: 1450

A coatings inspector in a BWR standby liquid control (SLC) system RCA encounters sodium pentaborate residue on degraded vinyl coatings, with B-12 (short-lived neutron capture) transients. RWP specifies neutron monitoring. Which neutron survey settings and decon formulas must be applied for residue removal?

A. Neutron rem-ball (e.g., Thermo 75-10), moderated with 10B polyethylene, energy response 0.025 eV-15 MeV, count rate <1 cpm background, alarm >0.1 mrem/hr.
B. Decon: 10% boric acid rinse (5% B-10, pH 7), followed by NaOH scrub (2N, 140°F), efficiency E = 1 - (Post / Pre), target >95% via gamma spec for B-12 daughters.
C. Dose equiv calc: H*(10) = φ_thermal × 2.7 (rem-sec/cm² per n/cm²/s) × Q=10, for 1E4 n/cm²/s flux, ensuring <50 mrem for 30 min.
D. Post-decon air: Sniffer probe for thermal neutrons (He-3 tube, 0.5 eV cutoff), scan at 6 inch/s, log variances >2σ for RWP closeout.

Answer: A, B, C

Explanation: SLC residues induce B-12 (0.95 MeV gamma, 20 ms half-life) via capture on B-10 (n,α), per ANL physics models, requiring rem-balls for quality factor 10 fast neutrons. Boric rinse leverages isotope exchange, NaOH for alkali solubles, E formula per IAEA decon guides. Flux-to-dose uses ICRP 74 conversion for tissue kerma; sniffer verifies but is secondary to primary neutron.

Question: 1451

A nuclear coatings inspector is verifying applicator qualification for CSL I coating application. Which documentation best confirms a qualified applicator?

A. Manufacturer’s recommendation letter for the applicator
B. Certificate of performance per ASTM D4228 showing successful skill demonstration
C. Completion of a common industrial paint application course
D. Supervisory approval on jobsite without certification

Answer: B

Explanation: ASTM D4228 certification is the recognized standard for verifying applicators qualified to apply nuclear CSL I coatings, ensuring skill in thickness control, coverage, and appearance critical to nuclear safety.

Question: 1452

EPRI Report 1019157 Section 4.5 maintenance for submerged safety-related coatings in condenser pits specifies biofouling controls. In a zebra mussel infestation scenario, which treatments and verifications?

A. Chlorination at 5 ppm free Cl2 for 24 hours, followed by dechlor flush to <0.1 ppm
B. Ultrasonic cleaning at 20 kHz, 120 dB, removing >95% biomass per ASTM G121 weight loss
C. Post-treatment inspection via borescope, no fouling thickness >0.1 inch per 10 ft^2
D. Biocide compatibility soak, <2% adhesion loss per ASTM D543 after 30 days

Answer: A, C, D

Explanation: EPRI addresses fouling eroding pit coatings. Chlorination targets mussels without delamination. Borescope confirms cleanliness for flow. Soak verifies biocide inertness, maintaining barrier.

Question: 1453

During a coating inspection, an inspector discovers inconsistent documentation in QA records. According to NQA-1 requirements, how must this be addressed?

A. File the records as-is with a notation of discrepancy
B. Initiate a record review and corrective action to ensure completeness and accuracy
C. Discard the records and redo the inspection
D. Ignore if physical inspections were satisfactory

Answer: B

Explanation: NQA-1 mandates thorough record management, requiring corrective measures when discrepancies arise to maintain QA integrity.

Question: 1454

Under RG 1.54, a 2026 NRC inspection at a U.S. BWR assesses epoxy coatings on containment sumps for DBA debris resistance at 0.5 m/s flow. Which qualification steps address incomplete debris data?

A. Debris testing per ASTM D7109 at 0.5 m/s, with ablation <4%
B. Post-debris adhesion testing per ASTM D4541, requiring pull-off strength >1000 psi
C. CFD modeling with drag coefficient $C_d = 0.5$, predicting particle settling $<0.05 \text{ g/cm}^2$
D. Documentation per 10 CFR 50.49, with test logs at ±3% flow accuracy

Answer: A, B, D

Explanation: RG 1.54 requires debris resistance for sump coatings. ASTM D7109 verifies ablation. Post-debris adhesion per D4541 ensures integrity. Documentation per 50.49 logs conditions. CFD modeling is analytical.

Question: 1455

Which method is preferred for measuring surface profile in nuclear coatings inspection and why?

A. Visual comparison to standard profile charts for quick evaluation
B. ASTM D4417 Method B (Replica Tape) for non-destructive accurate profile measurement
C. ASTM D4417 Method A (Micrometer) for rough surfaces
D. Thickness gauge readings for profile assessment

Answer: B

Explanation: Replica tape (Method B) allows precise, non-destructive measurement of surface profile critical for verifying nuclear coating substrate preparation, making it highly preferred over subjective visual methods or less accurate mechanical gauges.

Question: 1456

During a DBA qualification trial for a PWR containment liner coating, steam at 340°F induces blistering visible under 10x magnification. Using ASTM D714 standards adapted for nuclear post-accident functionality, which blister size-frequency pairs necessitate requalification of the entire system batch?

A. Medium No. 2 blisters on horizontal surfaces
B. Few No. 10 blisters uniformly
C. Dense No. 8 blisters in patches
D. Medium No. 4 blisters clustered

Answer: A, D

Explanation: In nuclear DBA testing, ASTM D714's medium No. 2 (large blisters, moderate frequency) or medium No. 4 (moderate size, clustered) denote failure modes like vapor barrier loss, risking coating detachment and ECCS impairment. These exceed allowable thresholds for CSL I, where even moderate large-blister incidences can lead to >1 g/100 cm² debris yield, violating EPRI TR-109937 criteria. Few No. 10 or dense small No. 8 are often deemed passable if leachables remain <10^-4 g/cm² per ASTM D3862.

Question: 1457

ANSI N5.12 addressed protective coatings for which specific NPP system prior to the ASTM replacement?

A. Water-cooled nuclear power plant systems including primary and secondary circuit components
B. Dry storage facilities exclusively
C. Non-nuclear HVAC systems
D. Electrical conduit protection only

Answer: A

Explanation: ANSI N5.12 targeted protective coatings within water-cooled NPP systems, providing specifications for corrosion prevention before more comprehensive ASTM standards superseded it.

Question: 1458

A nuclear coatings inspector measuring surface profile following SSPC-SP 10 uses ASTM D4417 Method B (replica tape). The measurement reads 3.2 mils. The specification requires 2.5–3.0 mils. What should the inspector recommend?

A. Accept as within tolerances considering measurement error
B. Apply coating with reduced dry film thickness to compensate
C. Reject surface preparation and request re-blasting to reduce profile

D. Approve if other surface cleanliness criteria are met

Answer: C

Explanation: Excessively high surface profile can lead to poor coating adhesion and rough surfaces that compromise performance. Specifications are strict for nuclear applications. Measurement above upper limits must be corrected by re-blasting to maintain coating integrity.

Question: 1459

During a BWR torus immersion coating inspection, a multi-layer system (epoxy primer 6 mils, glass-flake vinyl ester 15 mils, novolac topcoat 12 mils) undergoes simulated DBA LOCA testing at 330°F, 120 psig, pH 5.5 borated spray, 80 Mrad TID. Post-test, 0.9% weight loss is recorded, but 0.13 in. debris clogs mock ECCS strainers. Which parameters must be adjusted to meet debris limits?

A. Adjust spray chamber to cycle pH 4-6 over 60 days, verifying no blisters >#4 per ASTM D714
B. Incorporate 8% polymeric microspheres in topcoat to limit debris size to <0.10 in.
C. Recalibrate coating system DFT: primer 5 mils, vinyl ester 18 mils, novolac 15 mils; total >38 mils
D. Perform pull-off adhesion test per ASTM D4541; require >2500 psi post-DBA exposure

Answer: B, C, D

Explanation: Debris size 0.13 in. exceeds ASTM D3911’s 0.125 in. limit, risking ECCS strainer blockage; microspheres reduce fragment size by enhancing film cohesion. Increased DFT strengthens the multi-layer system, reducing weight loss and delamination under prolonged immersion. Post-DBA adhesion >2500 psi ensures coating integrity in torus environments under thermal and radiation stress.