PRACTICE EXAM 6: RED SEAL WELDER SIMULATION (125 QUESTIONS)

1. Under the Transportation of Dangerous Goods Regulations (TDGR), a vehicle transporting acetylene cylinders must comply with specific requirements due to acetylene's dual classification as a flammable gas AND an unstable gas. Which transport requirement most accurately reflects the obligation for a delivery vehicle carrying multiple acetylene cylinders to a construction site?

A. Acetylene cylinders must be transported horizontally in sealed metal containers to prevent acetylene from separating from the acetone carrier liquid during road vibration, which causes gas pressure instability at the valve

B. Acetylene cylinders must be transported upright with valve protection caps installed and secured against tipping, and the vehicle must display the appropriate UN1001 dangerous goods placard for quantities that exceed the small quantity exemption threshold under Schedule 1 of the TDGR

C. No placarding is required for acetylene cylinders transported in a standard pickup truck provided the total gas volume does not exceed the capacity of two standard cylinders — consumer quantities are exempt from all TDGR labeling requirements

D. Each acetylene cylinder must be individually chained to the vehicle frame using a dedicated retaining bracket rated for the cylinder mass multiplied by a dynamic load factor of 3G for road transport over unpaved surfaces

2. A welder discovers that the ventilation exhaust hood above the welding station has been disconnected from the extraction duct and is no longer removing fumes from the work area. The supervisor acknowledges the problem but says repairs are scheduled for next week and directs the welder to continue using the station. Under Canadian OHS legislation, what is the welder's right and what is the correct procedure for exercising it?

A. The welder must file a formal written grievance through the union within 24 hours — grievance procedures are the only legally recognized mechanism for addressing health and safety disputes between workers and supervisors in unionized fabrication environments

B. The welder should purchase a personal airpurifying respirator and submit the receipt to the employer for reimbursement — purchasing PPE as a substitute for the engineering control satisfies the employer's due diligence requirement and allows work to continue safely

C. The welder must continue working until the JHSC monthly meeting where the ventilation deficiency can be formally placed on the agenda — the right to refuse cannot be invoked for conditions that have a scheduled repair date

D. The welder has the right to refuse work that they have reasonable cause to believe presents an undue hazard to health — the welder must notify the supervisor of the refusal and its basis, allow a JHSC investigation, and if unresolved, the OHS authority may be contacted; the welder cannot be disciplined for a goodfaith refusal under these circumstances

3. A welder witnesses a coworker receive an electrical shock from a GMAW gun and observes the coworker is still in contact with the energized electrode. What is the absolute first action the rescuer must take before providing any assistance to the victim?

A. Ensure the rescuer's own safety by deenergizing the power source at the nearest disconnect switch or breaking the victim's contact with the energized conductor using a nonconductive object — touching the victim while contact is maintained will transfer the current to the rescuer and create a second victim

B. Call for emergency services immediately while pulling the victim clear of the electrode — initiating the 911 call takes priority because emergency response time is the primary determinant of survival in electrical shock incidents

C. Check the victim's breathing and pulse from a safe distance before touching — an initial ABCs assessment from 1 metre is required before any physical contact with a victim who may still be in contact with the electrical source

D. Apply dry rubber welding gloves before pulling the victim free — insulated welding gloves rated for lowvoltage applications provide sufficient protection to safely contact a victim in contact with any GMAW power source output voltage

4. A structural welder performs horizontal fillet welds on a fabrication table requiring a bentatthewaist posture with the head held at approximately 30 degrees of forward flexion for the full shift. Which musculoskeletal injury risk is most directly associated with this sustained posture, and what administrative control most effectively reduces it?

A. Carpal tunnel syndrome from repetitive wrist flexion during electrode manipulation — the primary control is antivibration electrode holder padding that reduces cumulative grip force requirements throughout the shift

B. Knee and ankle strain from prolonged static standing — antifatigue matting and shift rotation are the primary administrative controls since the posture described primarily loads the lower extremities during horizontal welding

C. Cervical and upper thoracic spine strain from sustained forward head posture combined with trunk flexion — repositioning the work to a height and angle that allows a neutral spine posture, supplemented by scheduled microbreak rotation, most directly reduces the sustained postural loading on the neck and upper back

D. Rotator cuff injury from sustained shoulder abduction — shoulder injuries are the primary MSI risk during bentatthewaist horizontal welding, and a shoulder support brace worn throughout the shift is the most effective administrative control for this specific posture

5. After completing hot work in an industrial facility, what is the minimum fire watch duration required after all hot work has ceased, and what specific activity does the fire watch perform during this period?

A. The fire watch must remain for 5 minutes and actively extinguish any visible sparks — once all sparks are confirmed extinguished within this period, the fire watch requirement is satisfied and the area may be released for normal operations

B. The fire watch must remain at the work site for a minimum of 30 minutes after all hot work has stopped — the fire watch monitors for delayed ignition of combustibles that were heated but did not ignite immediately during the work, since smoldering can persist and develop into fire well after the hot work tool is removed from the area

C. The fire watch must remain for 10 minutes for standard welding operations, with a 60minute watch required only when cutting operations are performed — the 10minute standard accounts for the faster spark decay rate associated with SMAW and GMAW arc welding versus thermal cutting

D. The fire watch must remain for 15 minutes for all hot work and must physically touch every surface within 3 metres of the work area to confirm ambient temperature before the area is released — contact temperature verification is the legally required standard for hot work completion inspection

6. A welder working at a noise level of 95 dB(A) for a full shift requires hearing protection that reduces exposure to the 85 dB(A) occupational exposure limit. Using the NIOSH derated method where effective protection equals (NRR − 7) ÷ 2, what is the minimum rated NRR the hearing protector must have?

A. NRR 27 minimum — required attenuation = 95 − 85 = 10 dB. Applying the NIOSH derating formula: (NRR − 7) ÷ 2 ≥ 10, therefore NRR − 7 ≥ 20, therefore NRR ≥ 27

B. NRR 10 minimum — the required noise reduction equals the simple difference between the exposure and the OEL, and the NRR value is applied directly without any derating factor for employer hearing protector selection decisions

C. NRR 20 minimum — the NIOSH method divides the full NRR by 2 without the 7 dB spectral correction, so 10 dB required attenuation × 2 = NRR 20 minimum rating for this exposure level

D. NRR 14 minimum — the derating method applies a 25% efficiency reduction to the NRR and requires an additional 2 dB safety margin for workplace uncertainty, giving a minimum rated value of 14 for 10 dB of required attenuation

7. A fabrication shop generates approximately 30 kg per month of grinding dust collected from the shop's dust collection system. The dust contains manganese, hexavalent chromium, and nickel from grinding stainless steel and alloy steel components. Before this material can be disposed of, what determination must the shop make?

A. The dust is classified as inert construction waste and may be placed in standard industrial waste containers for disposal through the municipal solid waste collection system, since abrasive grinding media classify the material as a mechanical rather than chemical waste

B. The dust must be tested for total combustible content only — if the dust does not ignite when exposed to a pilot flame, it qualifies as nonhazardous waste and can proceed to standard landfill without further testing or special handling

C. No determination is required for quantities under 100 kg per month — federal and provincial environmental regulations provide an automatic smallquantity exemption for manufacturing waste below this monthly generation threshold

D. The dust must be characterized to determine whether its heavy metal content meets the criteria for designation as hazardous waste — hexavalent chromium, manganese, and nickel in grinding dust can trigger hazardous waste classification under federal and provincial environmental legislation, requiring licensed hazardous waste manifesting, transport, and disposal

8. A welder working inside a boiler at 45°C ambient while wearing full leather welding PPE begins sweating heavily, feels weak and nauseated, and reports a headache but remains mentally coherent. A second worker nearby shows absence of sweating, is confused, and has a measured skin temperature of 41°C. Which condition classification and response applies to the second worker?

A. The second worker has heat exhaustion — heavy sweating is replaced by lack of sweating as the condition worsens, and oral fluid replacement with a 30minute cool rest period is sufficient to achieve full recovery from this intermediate heat illness stage

B. The second worker has heat syncope — the absence of sweating combined with confusion is the defining clinical presentation of heat syncope, and the worker must be immediately placed in a headdown position to restore cerebral perfusion pressure

C. The second worker has heat stroke — characterized by a core temperature above 40°C combined with absent sweating and altered mental status, heat stroke is a lifethreatening medical emergency requiring immediate aggressive cooling and emergency medical response

D. The second worker has dehydrationrelated hyponatremia — the absence of sweating and confusion indicate excess sodium loss rather than heat illness, and the treatment is oral sodium replacement rather than cooling, since cooling would worsen the electrolyte imbalance

9. A welding crew assembles scaffold for work at 4 metres above grade. The scaffold has a posted capacity of 1,100 kg. The crew will have 3 welders averaging 95 kg each, welding equipment and materials totalling 280 kg, and a welding power source weighing 120 kg on the platform. What is the total imposed load, and is it within the rated capacity?

A. Total load = 785 kg; compliant — weight is calculated as (3 × 95) + 280 = 565 kg for workers and materials; the power source is excluded from platform load calculations since it is classified as mobile equipment rather than a dead load under Canadian scaffold standards

B. Total load = 685 kg; compliant — total load = (3 × 95) + 280 + 120 = 285 + 280 + 120 = 685 kg, which is below the posted 1,100 kg capacity by a margin of 415 kg, confirming the scaffold configuration is within its rated load limit

C. Total load = 685 kg; noncompliant — powered electrical equipment placed on a scaffold platform automatically reduces the effective rated capacity by 50% under CSA scaffold standards, making the effective maximum 550 kg for this configuration and the 685 kg load noncompliant

D. Total load = 975 kg; compliant — powered welding equipment has a reduced weight factor of 0.7 applied to its rated mass under rigging conventions, making the power source contribute only 84 kg to the total, yielding 285 + 280 + 84 = 649 kg total load

10. A newly hired welder requests clarification about a welding flux with a WHMIS 2015 supplier label showing the health hazard pictogram — an exclamation mark inside a diamond. What specific health hazard class does this pictogram represent, and what does it require of the employer?

A. The health hazard exclamation mark pictogram covers categories including skin and eye irritation, skin sensitization, acute toxicity at lower concern levels, specific target organ toxicity for single exposure, and respiratory tract irritation — the employer must ensure the SDS is accessible and that workers have been trained on the specific hazards identified in Sections 2 and 11 before the product is used

B. The exclamation mark pictogram is the WHMIS 2015 symbol for explosive substances — it communicates that the flux contains components that can detonate under specific thermal or mechanical conditions and requires segregated storage away from all ignition sources

C. The exclamation mark pictogram indicates an environmentally hazardous substance — it communicates that the flux must not be discharged to waterways and requires secondary containment containers for all storage and dispensing operations involving this product

D. The exclamation mark pictogram represents the compressed gas hazard class under WHMIS 2015 — it indicates the flux container is under internal pressure and must be stored away from heat sources, and workers must wear face shields when opening any container displaying this symbol

11. A welder wearing a fullbody harness connected to a 1.8metre energyabsorbing lanyard with a 0.3metre deceleration distance falls from a work platform. The connecting Dring is located 1.4 metres above the worker's feet at the time of the fall, and the harness elongation under load adds 0.3 metres. What minimum clear fall distance must exist below the anchor point?

A. 2.1 metres — minimum clear distance equals lanyard length plus deceleration distance: 1.8 + 0.3 = 2.1 metres; Dring height and harness elongation are measured before the fall and are not additive to the dynamic arrest distance

B. 3.5 metres — minimum clear distance equals lanyard length plus deceleration distance plus the Dring height above the worker's feet: 1.8 + 0.3 + 1.4 = 3.5 metres, not including harness elongation which is covered by the energy absorber rating

C. 4.1 metres — minimum clear distance includes lanyard length plus deceleration distance plus Dring height plus a mandatory 0.3metre ground clearance factor: 1.8 + 0.3 + 1.4 + 0.3 + 0.3 = 4.1 metres for any fall arrest system in structural applications

D. 3.8 metres — minimum clear distance equals lanyard length (1.8 m) plus deceleration distance (0.3 m) plus Dring height above feet (1.4 m) plus harness elongation (0.3 m) = 3.8 metres minimum between anchor point and any lower surface that must remain unobstructed for the system to arrest the fall without contact

12. A welder has been welding inside a partially enclosed stainless steel tank using pure argon for GTAW shielding. After one hour, the welder feels dizzy and lightheaded. A coworker immediately enters the tank to assist. What specific atmospheric hazard is present, and what critical error did the coworker make?

A. The welder is experiencing ozone toxicity from UVgenerated ozone at the GTAW arc — the coworker correctly entered since ozone dissipates within seconds at the tank entry, making the hazard effectively zero by the time a rescuer reaches the welder's position

B. The welder is experiencing nitrogen dioxide toxicity from arcgenerated NO_x compounds — the coworker's error was entering without respiratory protection, since NO_x concentrations remain hazardous for up to 30 minutes after the arc is extinguished in enclosed spaces

C. The welder is experiencing oxygen deficiency from argon accumulating in the tank — argon is a colourless, odourless asphyxiant that displaces oxygen and pools in low areas; the coworker's critical error was entering without first testing the atmosphere and alerting the standby person, placing both workers at simultaneous risk of incapacitation in the oxygendepleted environment

D. The welder is experiencing heat exhaustion from reflected heat inside the tank — the coworker correctly entered immediately since a conscious heat exhaustion victim requires manual assistance to exit the warm environment before the condition progresses to heat stroke

13. Under CSA W47.1, a certified welding company must maintain specific documentation throughout the life of the certification. Which records must be available for CWB audit at any time during the active certification period?

A. The company's current welding procedure specifications, the supporting procedure qualification records demonstrating each WPS is backed by valid PQR testing, and all active welder qualification records — these documents together demonstrate that both the procedures and the personnel performing production welding are qualified under the certification requirements

B. Only the final inspection reports for completed projects — the WPS and PQR are manufacturing support documents that transfer to the vessel owner upon project completion and need not be retained by the fabricating company beyond project handover

C. Only currently active welder qualification certificates — expired certificates and the WPS documents are maintained by the CWB central registry and are available through the national welder database rather than through the company's own records

D. Only the purchase orders and material test reports for welding consumables — consumable lot traceability is the sole audit focus under W47.1 certification assessments and procedure documentation is considered supplementary information beyond the certification scope

14. A welder must select a lens shade for SMAW welding using E7018 electrodes at approximately 250 amperes with a 6 mm diameter electrode. Which shade provides the appropriate protection for this specific combination of electrode diameter and current level?

A. Shade 10 — all SMAW applications regardless of electrode diameter or amperage require shade 10 minimum, and increasing beyond this level unnecessarily reduces arc visibility without providing additional protection from the UV and IR output of standard SMAW electrodes

B. Shade 12 — for SMAW with electrode diameters above 4 mm or amperage above 200 A, the recommended minimum filter shade is 12, providing appropriate ultraviolet and infrared filtration at this current and electrode size combination while maintaining adequate arc pool visibility

C. Shade 14 — basiccoated electrodes in the 7018 classification produce significantly more infrared radiation than rutile electrodes due to the iron powder fume in the flux sheath, requiring the maximum protective shade for all E7018 applications regardless of amperage

D. Shade 8 — the iron powder coating in E7018 electrodes absorbs a substantial portion of the arc's ultraviolet output within the flux sheath before it exits the arc zone, making E7018 welding substantially safer than other electrodes and requiring only a shade 8 filter

15. A fabrication shop performs radiographic testing using an iridium192 source. Under Canadian Nuclear Safety Commission regulations, which workers in the facility must be included in the dose monitoring program even if they do not directly handle the source?

A. Only the certified radiographers who handle the Ir192 source physically — support staff and fabrication workers in adjacent areas are not subject to dose monitoring since all RT exposures are performed behind a fully shielded barrier that prevents any dose from reaching uncontrolled areas

B. Only workers physically present in the controlled area during exposures — the monitoring requirement applies exclusively within the controlled area boundary established by the postexposure radiation survey, and workers outside this boundary receive no measurable dose

C. No fabrication workers require monitoring — industrial radiography is classified as lowhazard industrial use under CNSC licensing and provides automatic exemption from individual dose monitoring for all nonradiation workers

D. Any worker who could receive a measurable dose from RT operations must be evaluated for inclusion in the dose monitoring program — this potentially includes welding workers in adjacent areas if dose rate surveys indicate they could approach regulatory dose limits during a shift, regardless of whether they are involved in the RT work

16. A pipe welder performs 5G fixedposition pipe welding on 200 mm diameter pipe repeatedly throughout an 8hour shift. What is the primary ergonomic concern that distinguishes 5G from 1G (rotated pipe) welding, and which body region is most at risk?

A. The 5G position requires continuously transitioning through overhead, vertical, and flat welding zones without pipe rotation — the overhead segment demands sustained awkward arm elevation and neck extension that do not occur in 1G work, creating elevated cumulative loading risk for the shoulder complex and cervical spine over extended production shifts

B. The 5G position requires the welder to walk around the pipe circumference, creating a higher aerobic demand that exceeds the safe cardiovascular output for continuous 8hour welding shifts — scheduled walkaround breaks every 90 minutes are required under physical exertion guidelines for heavy industrial welding

C. The 5G position requires the welder to continuously adjust amperage as the joint orientation changes around the circumference — the repetitive control panel interaction creates a pinchgrip overuse injury pattern in the dominant hand that is absent in 1G welding where consistent parameters are maintained throughout the joint

D. The 5G position presents identical ergonomic risk to 1G welding since the joint dimensions and welding parameters are the same — any difference in physical demand is attributable to individual welder technique and body mechanics rather than any inherent positional demand

17. A welder's helper will degrease joint preparations using a solvent with a flashpoint of 23°C. The shop temperature is 28°C. Which WHMIS 2015 pictogram must appear on the supplier label, and what does the combination of flashpoint and ambient temperature indicate about the immediate fire hazard at the point of use?

A. The compressed gas cylinder pictogram — a flashpoint below ambient temperature indicates the solvent contains dissolved gas that becomes pressurized when the container is opened in a warm environment, and the pressurized vapor creates a flash fire hazard only during container opening

B. The skull and crossbones pictogram — a flammable solvent with a flashpoint below ambient temperature is automatically classified as an acute toxic substance because the high vapor concentration at ambient temperature exceeds the IDLH before adequate ventilation is established

C. The flame pictogram — a flashpoint of 23°C below the ambient temperature of 28°C means the solvent surface is continuously generating sufficient vapor to form a flammable mixture with air at the work location, and any ignition source near the open container — including grinding sparks, static discharge, or hot metal — can cause immediate ignition

D. The exploding bomb pictogram — WHMIS 2015 classifies any flammable liquid with a flashpoint below 37.8°C as an explosive substance because the high vapor pressure at ambient temperature creates an explosive concentration in any partially enclosed space within seconds of opening the container

18. A welder is assigned to perform SMAW repairs inside a stainless steel vessel approximately 2 metres in diameter with a single 600 mm diameter manway entry, using E308L16 electrodes. Given the stainless steel fume will contain hexavalent chromium, which respiratory protection is most appropriate?

A. A halfface airpurifying respirator with a combination P100/organic vapour cartridge provides sufficient protection for all confined stainless steel SMAW — the P100 filter efficiency of 99.97% removes all hexavalent chromium particles at any concentration generated by standard SMAW operations in vessels of this size

B. A suppliedair respirator or selfcontained breathing apparatus is required — in a small enclosed space with a single limited entry, welding fume including Cr(VI) can rapidly accumulate to concentrations that exceed the capacity of airpurifying cartridge systems, and only atmospheresupplying respiratory protection provides reliable protection in this confined space welding configuration

C. No respiratory protection is required provided the singleentry manway provides adequate passive ventilation — the 600 mm diameter opening provides sufficient natural air exchange to keep Cr(VI) concentrations below the OEL without forced ventilation or respiratory protection

D. A disposable N95 filtering facepiece provides adequate Cr(VI) protection in all welding environments including confined spaces — the N95 certification specifically covers transition metal oxide particles including hexavalent chromium and is the respirator mandated by NIOSH for stainless steel welding in restricted areas

19. Under Canadian OHS regulations, a Joint Health and Safety Committee member assigned to conduct workplace inspections must have received what minimum training before performing these inspections?

A. A 2hour facility orientation covering emergency response procedures and the location of fire exits is sufficient to qualify a JHSC member to conduct all required inspections — the inspection role requires familiarity with the facility layout rather than formal health and safety training

B. A minimum of 6 months of work experience at the facility before being assigned to JHSC inspections — experiential familiarity with the workplace replaces formal training requirements for workers who have been exposed to the actual hazards during their own daily work activities

C. A current standard first aid certificate from a recognized provider is the prerequisite for the JHSC inspection role — first aid training provides the injury recognition and health assessment skills that are the foundation for identifying health and safety hazards during workplace inspections

D. Training that includes the applicable OHS legislation, hazard recognition and assessment methods, workplace inspection procedures, and incident investigation principles — the specific content and duration are established by the applicable provincial or territorial OHS legislation, and the training must be completed before the member performs formal inspection duties

20. A welder's selfcontained breathing apparatus has been in storage for three months since its last use. Before using it for a confined space entry, what inspection must be performed, and what is the qualification requirement for the person performing each component?

A. A visual check of the facepiece seal by the welder is the only required preuse inspection — SCBA units are engineered for extended storage stability and no additional inspection beyond the user's physical examination is required between annual scheduled servicing events

B. A full scheduled maintenance inspection at the annual interval is the only inspection required — between annual maintenance events, the welder's standard preentry check satisfies all inspection requirements under Canadian confined space and breathing apparatus standards

C. The welder performs a preuse inspection confirming no visible damage, adequate cylinder pressure, and a positivepressure facepiece seal check before each use, and a competentperson periodic inspection per the manufacturer's schedule is performed by trained maintenance personnel to verify all components including regulator function and cylinder hydrostatic test currency are within service limits

D. SCBA units stored for more than 60 days require factory recertification before reuse — a 3month storage period automatically voids the inservice status of the breathing apparatus and requires return to an authorized service centre regardless of the unit's apparent physical condition or cylinder pressure

21. A structural drawing shows a welding symbol with a groove weld on the arrow side, "CJP" written above the reference line, a filled triangle flag at the reference line junction, and the number "6" to the left of the groove symbol. What is the complete and correct interpretation of this combined symbol?

A. A complete joint penetration groove weld with 6 mm specified effective throat to be made in the field — "CJP" specifies full penetration from the arrow side, "6" indicates the effective throat dimension, and the filled flag designates this as a field weld to be completed at the construction site rather than in the shop

B. A CJP groove weld with a 6 mm root opening to be completed with full volumetric NDE — the filled flag designates mandatory inspection, "6" indicates the required root opening, and "CJP" confirms that full joint thickness penetration must be demonstrated through the examination

C. A doubleV groove weld where "6" indicates the groove angle per side in degrees, "CJP" designates mandatory complete inspection before acceptance, and the field weld flag indicates the joint was specifically designed for field conditions rather than shop fabrication

D. A partial joint penetration weld with 6 mm effective throat — in structural drawings, "CJP" is an abbreviation for "Calculated Joint Procedure" and the 6 mm value designates the maximum root gap permissible before the joint must be refitted prior to depositing the weld

22. A fabricator must develop a flat pattern for a transition section that changes from a 450 mm diameter round duct at one end to a 400 mm × 250 mm rectangular duct at the other, with a perpendicular height of 350 mm. Which pattern development method is appropriate, and why does the alternative method fail for this geometry?

A. Parallel line development — both the round and rectangular ends maintain constant crosssectional profiles along generators parallel to the transition axis, and the parallelline unrolling technique accurately develops this surface without triangular approximation

B. Triangulation development — the surface of a roundtorectangular transition is a warped, doublycurved surface that cannot be described by either parallel generators or a single convergent apex; triangulation approximates this nondevelopable surface by dividing it into small triangular facets and developing each triangle's true shape independently

C. Radial line development — the round and rectangular ends converge to a common geometric apex when extended, making radial line development the exact method for this transition geometry and producing a flat pattern without any approximation

D. Contour line development — both the round and rectangular crosssections can be averaged into an equivalent elliptical profile at each elevation, and the contour lines produce an exact flat pattern based on the arc length at each contour elevation

23. Under ASME Section IX, a GTAW procedure was qualified using ER316L filler metal (ANumber 8 deposit). The fabrication engineer proposes changing to ER309L for production welding on the same stainless steel base metal. How is this filler metal change classified under ASME IX?

A. Nonessential variable — both ER316L and ER309L are classified under SFA5.9 austenitic stainless steel filler metals, and the same SFA specification classification means the change is within the scope of a simple WPS amendment with no additional testing

B. Supplementary essential variable that becomes mandatory only when the welding procedure requires Charpy impact testing at or below −29°C — at ambient or higher service temperature, the ANumber change is nonessential and does not require additional PQR testing

C. Minor administrative change requiring only a WPS revision with supervisor authorization — the FNumber for both ER316L and ER309L is the same (FNumber 6), and changes within the same FNumber are freely permitted under ASME IX without PQR testing

D. An essential variable change under ASME IX QW404 — the shift from ANumber 8 (ER316L, 1820% Cr, 812% Ni with Mo) to ANumber 9 (ER309L, 2226% Cr, 1214% Ni) changes the deposited weld metal composition classification, requiring new PQR qualification testing to support the amended WPS

24. Under CSA W59, weld access holes are required at beam webtoflange junctions in structural moment connections. What is the most critical quality requirement for weld access hole edges on dynamically loaded structures, and why is it specified?

A. The weld access hole must be completely filled with weld metal after the main connection weld is deposited — filling the access hole restores the original member crosssection area and eliminates the geometric change that would otherwise reduce the effective net section under dynamic loading

B. The weld access hole edges must be parallel to the flange surface within 2 degrees — nonparallel access hole edges create a skewed fusion plane for the webtoflange weld that reduces effective throat and produces asymmetric stress distribution at the weld root

C. The weld access hole perimeter must be smooth, free of notches, reentrant corners, and gouges from the cutting operation — these geometric discontinuities create stress concentration factors that initiate fatigue cracks at the hole boundary under cyclic loading; finish grinding to remove all surface defects from thermally or mechanically cut edges is specified for all dynamic loading applications

D. The weld access hole must have a diameter exactly equal to the connecting plate thickness — this dimensional requirement ensures electrode access to the full depth of the webtoflange joint from both sides of the connection during assembly

25. Two structural flat plates are properly tackwelded, clamped, and buttwelded with a long longitudinal weld along the upper surface. After releasing the clamps, the assembly bows upward at the center and both plate ends lift off the flat table. What is this distortion called and what is the primary mechanical cause?

A. Longitudinal bowing — the weld metal deposited along the upper plate surface contracts during cooling, shortening the upper surface relative to the plate's neutral axis; this differential contraction causes the upper surface to become concave relative to the plate length, pulling the plate ends upward and creating the observed centerup bow toward the weld side

B. Transverse buckling — the perpendicular shrinkage forces across the weld create a sinusoidal buckle pattern in the plate plane that appears as a bowing artifact when the plate is viewed from the end, but the actual deformation is lateral rather than longitudinal

C. Angular distortion cascade — the clamping and release sequence creates angular rotation at the tack welds that propagates along the joint as each tack is released, accumulating into the apparent longitudinal bow through an additive rotation mechanism

D. Creep deformation — the sustained elevated temperature of the heataffected zone after welding causes the plate to creep upward under its own gravitational weight until the material temperature drops below the creep threshold, producing the permanent upward bow described

26. A radiographic interpreter evaluates a multipass SMAW groove weld film and finds dark elongated indications with small rounded ends arranged at irregular intervals along the weld centerline. The indications are 3 to 6 mm long and appear to have the primary axis aligned with the weld. What discontinuity type is most consistent with this RT film description?

A. Lack of fusion at the groove sidewall — elongated dark indications with rounded ends at the weld centerline are the characteristic RT appearance of incomplete sidewall fusion, where the unfused plane creates the elongated dark zone with the rounded endpoints at the weld pass boundaries

B. Lamellar tearing — curved linear dark zones with rounded ends at the plate midthickness represent throughthickness planar tearing perpendicular to the rolling direction of the structural plate, and their position at the weld centerline confirms the base metal throughthickness stress exceeded the lamellar tear threshold

C. Interpass cold laps — the dark roundedend elongated zones are characteristic of cold lap overlaps that form at the junction of successive passes where the underlying pass was too cool for proper fusion, and their alignment with the weld centerline is the defining RT feature of this defect type

D. Elongated (piping) porosity — dark elongated wormhole voids with characteristically rounded ends arranged near the weld centerline are produced by sustained gas contamination from a single source (moisture, hydrocarbons, or cracked coating) acting continuously at the pool during deposition

27. A fabricator must join a Type 304 austenitic stainless steel nozzle to a Grade 91 (P5B) ferritic alloy steel pressure vessel shell using a butter layer technique. The engineer specifies ER309L as the butter layer filler rather than ER308L. What is the technical justification for selecting ER309L over ER308L for buttering the P91 surface?

A. ER309L has a lower carbon content than ER308L, and the lower carbon prevents carbide precipitation in both the 304 HAZ and the P91 HAZ during postweld heat treatment — ER308L's elevated carbon content would cause widespread sensitization in both base metals during the 760°C PWHT

B. ER309L contains higher chromium (2325%) and nickel (1214%) than ER308L (1921% Cr, 911% Ni) — the overalloyed chemistry accommodates the iron and alloy element dilution from the P91 base metal during buttering without the deposit chemistry falling below the minimum chromium and nickel levels required for the filler to remain austenitic and maintain adequate corrosion resistance

C. ER309L is the only SFA5.9 filler metal with ASME IX qualification for use with PNumber 5B base metals — ER308L does not have P5B qualification and cannot be used for any joint involving P91 steel under ASME IX Section IX or B31.3 codes

D. ER309L filler wire is manufactured exclusively in small diameters suitable for GTAW root passes on nozzle connections, while ER308L is only produced in diameters appropriate for GMAW applications on flat plate configurations

28. A structural engineer reviews a fabrication drawing and finds a structural bracket designed with a fullpenetration weld that terminates at a sharp 90degree internal corner where two plate sections intersect. Under cyclic fatigue loading, what structural concern does this detail create?

A. The 90degree internal corner creates a weld toe undercut condition that cannot be corrected by postweld grinding — the only acceptable solution is to redesign with a boxed corner configuration that eliminates the geometric constraint at the weld termination

B. The full penetration requirement at a 90degree internal corner makes it impossible to achieve adequate electrode access from either direction — the joint design is geometrically incompatible with full penetration welding and must be converted to a partial penetration fillet connection

C. The abrupt 90degree internal corner at the weld termination creates a stress concentration factor that can initiate fatigue cracks under cyclic loading — adding a smooth transition radius (cope radius or corner fillet) at the reentrant corner location reduces the geometric stress concentration factor and extends the fatigue life of the connection detail

D. The corner detail requires identical preheat application to both intersecting plates before welding — unequal preheating creates a temperature differential that generates transverse residual stress at the weld termination point, initiating transverse cracks in all structural bracket applications with 90degree internal corner terminations

29. Under ASME Section IX QW451.1 for groove welds, a SMAW procedure was qualified using a 12 mm thick test coupon. What is the minimum base metal thickness for production groove welds supported by this PQR?

A. 6 mm minimum — for test coupon thickness T between 4.8 mm and 19 mm, QW451.1 specifies a qualified production range from T/2 to 2T; for a 12 mm coupon, the minimum is 12 ÷ 2 = 6 mm and the maximum is 12 × 2 = 24 mm

B. 1.5 mm minimum — ASME IX provides a universal minimum of 1.5 mm for all SMAW procedures regardless of test coupon thickness, with only the maximum qualified thickness varying based on the coupon dimensions used in the PQR

C. 3 mm minimum — the standard minimum qualified thickness is always the test coupon thickness divided by 4, providing 12 ÷ 4 = 3 mm minimum, with this calculation applying to all test coupon thicknesses in the QW451.1 table

D. 12 mm minimum — ASME IX does not permit production welding on material thinner than the qualification test coupon for groove welds — the PQR test coupon thickness is both the minimum and the lower bound for the qualified range regardless of the coupon thickness

30. A pipe fabricator routes a 2inch NPS pipe around an obstacle using two 45degree elbows, creating a 200 mm parallel offset. The 45degree elbow has a centretoface dimension of 38 mm. Using the formula that the diagonal travel distance equals offset ÷ sin(45°), what is the facetoface length of the spool between the two elbows?

A. 200 mm — the diagonal travel distance equals the offset distance when 45degree fittings are used because the elbow angle and offset create a geometric relationship where travel length numerically equals offset length

B. 283 mm — travel distance = 200 ÷ sin(45°) = 200 ÷ 0.707 = 283 mm; since the facetoface distance equals the centretocentre distance with no takeout deductions required for 45degree fittings, the spool is 283 mm face to face

C. 247 mm — travel distance = 200 mm × sin(45°) = 200 × 0.707 = 141 mm; facetoface = 141 + (2 × 38 takeout corrections) for both elbow ends = 247 mm including all fitting allowances

D. 207 mm — travel distance = 200 ÷ sin(45°) = 283 mm centretocentre; facetoface = 283 − (2 × 38) = 283 − 76 = 207 mm after subtracting the takeout dimension for both 45degree elbow fittings

31. Under CSA W59 prequalified joint provisions, a fabricator prepares a doubleV groove butt joint in 25 mm structural plate and measures the root face at 4.5 mm. The prequalified maximum root face for this joint configuration is 3 mm. What is the correct resolution of this nonconformance?

A. Proceed with welding and record the actual 4.5 mm root face in the traveller — CSA W59 permits root face deviations up to 2 mm beyond the prequalified maximum when the excess is documented, and the welder's signature on the production record constitutes formal acceptance of the deviation under the code's field tolerance provision

B. The root face must be corrected to within the prequalified 3 mm maximum before welding begins, or the joint must be formally requalified through a PQR test at the actual 4.5 mm root face dimension — proceeding to weld above the prequalified tolerance uses an unqualified procedure regardless of how the deviation is documented

C. The welder may accept the 4.5 mm root face by increasing the minimum preheat temperature by 25°C — elevated preheat compensates for the reduced root penetration associated with an oversized root face and constitutes a recognized technical substitution for dimensional compliance under CSA W59

D. The JHSC representative must sign the fabrication traveller acknowledging the 4.5 mm root face before welding can proceed — committee acceptance is the approved alternative to dimensional compliance for prequalified joints when the deviation is less than 2 mm above the specified maximum

32. A visual inspector measures undercut along the weld toe of a completed SMAW fillet weld on a dynamically loaded structural member. The measured undercut depth is 0.8 mm. The applicable code is CSA W59 for cyclically loaded structures. What is the correct acceptance decision?

A. Rejectable — CSA W59 limits undercut in cyclically loaded structural members to 0.25 mm maximum at the weld toe; a measured depth of 0.8 mm significantly exceeds this limit and the condition must be repaired by depositing additional weld metal or by mechanical blending to remove the notch

B. Acceptable — CSA W59 permits up to 1/16 inch (1.6 mm) undercut depth on all fillet welds in any loading classification, and the 0.8 mm measured depth falls within the general acceptance standard without any additional evaluation requirement

C. Acceptable for intermittent occurrence — undercut up to 0.8 mm depth is permitted on cyclically loaded members where the total length of undercut does not exceed onethird of the total weld length; a length measurement must be completed before the accept/reject decision can be finalized

D. Conditional acceptance pending engineering review — undercut between 0.5 mm and 1.0 mm depth falls in the conditional zone that requires the structural engineer to review the fatigue stress range and confirm the weld category before accepting the indication without repair

33. Before welding begins on a CSA B51 registered pressure vessel joint, a welding inspector must complete a preweld inspection. Which combination of items represents the minimum required verification for code compliance on a registered vessel?

A. Fitup geometry against the drawing dimensions only — the preweld inspection for pressure vessels is limited to the geometric dimensions of the joint preparation, and all other verification items are addressed by the certified welding supervisor's production approval

B. Base metal temperature and material heat number only — CSA B51 preweld inspection requirements are limited to two items: confirming the plate is above the minimum welding temperature and recording the heat number for traceability documentation

C. Joint preparation dimensions and root gap against WPS parameters, base metal identity confirmed against the MTR heat number, joint surface cleanliness and freedom from moisture and contaminants, and preheat confirmed at the minimum WPS requirement — each of these must be verified and recorded before the first arc is struck on any registered pressure vessel joint

D. Electrode or filler metal identification against the WPS classification only — all other preweld conditions are the qualified welder's responsibility under the CSA W47.1 certified company framework, and the inspector's preweld role is restricted to consumable compliance verification

34. A radiographic film evaluation finds that the densitometer reading in the weld zone is 1.6. The RT procedure requires a film density range of 2.0 to 3.5. What is the correct disposition of this film?

A. Accept the film — a density of 1.6 is within 25% of the minimum required density of 2.0, which falls within the stated ±0.3 density unit measurement uncertainty for calibrated analog densitometers, making the film technically within specification

B. Accept with notation — if the image quality indicators demonstrate the required sensitivity on the underexposed film, ASME Section V permits acceptance of films below the minimum density when IQI sensitivity is confirmed as adequate through direct assessment

C. Retake the radiograph after first performing a second densitometer calibration check — an underexposed film may result from densitometer miscalibration rather than actual underexposure, and the retake must not occur until equipment calibration is verified

D. The film is unacceptable and must be reshot — a density below the minimum required range means the film lacks sufficient sensitivity to reliably detect the minimum rejectable flaw size required by the applicable code; defects may be present but invisible at this underexposed density

35. During pressure vessel fabrication, a shell plate was cut to size and the original mill marking was inadvertently removed during the trimming operation. What procedure restores material traceability for this vessel component?

A. The cut plate may be used without reidentification if the plate thickness measured by calibrated ultrasonics confirms the dimensional specification — thickness compliance confirms the material grade for A516 Grade 70 without requiring chemical or documentationbased verification

B. The remaining partial heat number found on the cut plate edge must be transferred to a new accessible location using lowstress marking before any further operations; if the original identification was lost entirely, the plate must be reidentified through chemical analysis and hardness testing to reestablish specification compliance before it can be used

C. Batchlevel MTR traceability from the same heat of steel is sufficient for all nonnuclear pressure vessels — individual plate identification is not required when the certifying mill's MTR covers the full plate batch received on a single purchase order

D. An experienced inspector may confirm material identity through visual examination of the plate surface appearance and rust patterns — specialist inspectors can distinguish A516 Grade 70 from other plate grades by surface texture characteristics and the visual pattern of the mill scale without requiring documentationbased identification

36. A fabricator is welding a 300 mm × 300 mm × 25 mm base plate to the bottom of a structural column using four equallength fillet welds. To minimize angular distortion and maintain column perpendicularity, which welding sequence is most effective?

A. Deposit both webside fillet welds simultaneously using two welders, then deposit both flangeside fillet welds simultaneously using two welders — this balanced approach applies equal shrinkage forces on all four sides simultaneously, which minimizes angular distortion and preserves column perpendicularity through symmetric heat application

B. Deposit all four fillet welds sequentially in clockwise order around the column — the continuous circular progression maintains an even thermal gradient around the column base and prevents the directional distortion that occurs when opposite welds are completed in immediate sequence

C. Complete the full length of each fillet weld before moving to the adjacent one — each weld achieves full solidification and primary shrinkage before the next adjacent weld introduces heat, preventing any thermal interaction between adjacent weld passes during their individual solidification cycles

D. Complete the two shortest welds first then the two longer welds — shorter welds create stable reference points for the longer welds because they achieve their full shrinkage contribution in less arc time, reducing the net angular distortion from the combined shrinkage of all four base plate fillet welds

37. On an isometric piping drawing, a section of pipe is shown with a break symbol — a horizontal line passing through the pipe at one location with an open pipeend representation beyond it. What does this drawing convention communicate?

A. The lighter line section beyond the break represents pipe in a different material specification than the heavier section, requiring a material break weld and MTR documentation at the intersection of the two line weights on the isometric

B. The break symbol at the horizontal line represents the location of a circumferential weld joint — the change in line weight distinguishes between shopfabricated spool sections and fielderected pipe connections in the isometric drawing system

C. The break symbol indicates the pipe continues beyond the visible portion of the isometric drawing sheet — the open pipe end shown beyond the break is a drawing convention indicating continuation, not an actual open end; the spool continues with additional fittings, supports, or joints that are shown on the adjacent sheet referenced in the drawing set

D. The break symbol marks the location of a required loop expansion joint — pipe isometrics use break symbols at the entry and exit points of all expansion loops, and the line weight change beyond the symbol marks the flexible expansion section of the piping system

38. During structural fitup, a welder discovers that punched bolt holes in a gusset plate are located 35 mm from the intended fillet weld toe line. What specific welding quality concern does this close holetoweld proximity create, particularly in higherstrength structural steels?

A. The proximity to punched holes creates a magnetic flux concentration that intensifies arc blow and prevents stable arc operation within 40 mm of drilled or punched holes in any ferromagnetic structural steel used in connection plates

B. The 35 mm edgetoweld distance is below the minimum 50 mm specified by CSA W59 for all fillet welds deposited adjacent to fastener holes — this dimensional violation requires a drawing change to increase the hole spacing before welding can proceed

C. The punched holes create a workhardened annular zone within 25 mm of each hole edge that requires stressrelieving at 600°C before fillet welds can be deposited within this radius in any structural steel application

D. Welding heat applied close to punched bolt holes can cause localized embrittlement — the punching operation introduces cold work and residual stresses around each hole, and welding heat within a critical distance can create a susceptible HAZ microstructure, particularly in highercarbonequivalent steels where the combination of punching damage and weld thermal cycle increases cold cracking risk

39. Under CWB certification standards, a welder successfully completes the 6GR pipe groove weld qualification test. What positions and joint types does this qualification cover?

A. The 6GR qualification covers all groove weld positions on pipe including 1G, 2G, 5G, and 6G, and extends to plate groove welds in all positions — the 6GR with restriction ring is the most comprehensive pipe weld qualification under CWB standards and provides the broadest certification coverage available from a single test

B. The 6GR qualification covers only the 6G and 6GR positions — the restriction ring test certifies welding technique in the most physically demanding access configuration but does not extend coverage to any other pipe welding positions

C. The 6GR qualification covers all pipe groove positions but does not extend to plate groove welds — pipe and plate qualifications are maintained as separate certification categories under CWB standards, and a separate plate test is required to add plate groove welding to the certificate

D. The 6GR qualification covers all groove positions for the specific pipe diameter used in the test but does not extend to smaller diameters — pipe diameter is an independent essential variable under CWB standards and each diameter range below the test size requires its own separate qualification test

40. A SAW production run uses the following parameters: 700 A, 36 V, 600 mm/min travel speed. The WPS specifies a maximum heat input of 4.0 kJ/mm. Using HI (kJ/mm) = (V × A × 60) ÷ (speed mm/min × 1,000), what is the actual heat input and is it within the procedure limit?

A. HI = 4.20 kJ/mm; exceeds the procedure maximum — calculated as (36 × 700 × 60) ÷ (600 × 1,000) = 1,512,000 ÷ 360,000 = 4.20 kJ/mm, requiring immediate parameter adjustment before production welding continues

B. HI = 2.52 kJ/mm; within the procedure maximum — calculated as (36 × 700 × 60) ÷ (600 × 1,000) = 1,512,000 ÷ 600,000 = 2.52 kJ/mm, confirming the production parameters are well within the 4.0 kJ/mm qualified limit

C. HI = 3.02 kJ/mm; within the procedure maximum — calculated using the formula with the travel speed correction factor applied as an independent divisor: (36 × 700) ÷ (600 ÷ 60) × 0.001 = 3.02 kJ/mm, within the procedure limit

D. HI = 1.26 kJ/mm; within the procedure maximum — calculated by applying the amperage as a divisor rather than a multiplier in the numerator, following the alternative heat input formula for SAW that divides arc energy by the current level

41. An MT inspector must examine a completed structural weld outdoors at an ambient and component temperature of 2°C. Which magnetic particle technique applies to this coldtemperature inspection condition?

A. Wet suspension particle testing only — fluorescent wet particle suspensions are formulated with antifreeze compounds that maintain adequate particle mobility and suspension stability down to −25°C, while dry particles lose their magnetic response at temperatures below +5°C

B. Neither wet nor dry MT may be performed below 5°C — all MT examinations must be suspended and rescheduled until the component surface temperature reaches the minimum standard ambient condition of 5°C before any particles are applied

C. Dry magnetic particle powder is the appropriate choice for coldweather applications — dry particles maintain their magnetic mobility and detection sensitivity at 2°C since the powder is not susceptible to freezing or increased viscosity; wet suspension fluids can freeze or become excessively viscous at or near 0°C, losing the particle mobility needed to migrate to flux leakage sites

D. Either wet or dry particles may be used provided a calibrated thermometer is placed in the test area and readings are taken every 15 minutes — MT procedures at temperatures between 0°C and 10°C are conditionally accepted under both ASME V and AWS D1.1 provided temperature monitoring is documented

42. Under ASME Section VIII Division 1, a pressure vessel weld has failed ultrasonic examination and requires repair. Which steps must be completed before the repair weld can be deposited?

A. The defective zone must be removed by mechanical means only — thermal removal methods including gouging and grinding are prohibited for pressure vessel repair because the additional thermal cycle introduces HAZ microstructure changes that are more damaging than the original defect

B. The defective area must be excavated and visually examined only — volumetric examination of the repair preparation is required only for nuclear class components and is not mandated under Section VIII Division 1 for standard industrial pressure vessel repairs

C. No formal repair procedure is required — a welder holding a current qualification for the process and position may deposit the repair weld on the authority of the certified welding supervisor, and final acceptance is based on the postrepair visual examination result alone

D. The defective zone must be removed and the excavation verified by NDE to confirm complete defect removal, the repair must be deposited using a qualified WPS by a qualified welder, and the completed repair must be reexamined using the original examination method applied to the same acceptance criteria as the original production weld

43. A structural drawing specifies "8 mm fillet weld, E480XX electrode minimum" for a moment connection. The shop inventory contains only E480XXH8 electrodes. An inspector asks whether this substitution requires engineering approval. What is the correct assessment?

A. No engineering approval is required — E480XXH8 meets and exceeds the E480XX drawing specification; the H8 designation confirms the electrode produces the same minimum mechanical properties as standard E480XX with the additional verification of hydrogencontrolled performance; a more stringently tested product may always substitute for the base classification without authorization

B. Engineering approval is required — the H8 designation modifies the arc stability characteristics of the electrode through the flux chemistry changes needed to achieve hydrogen control, potentially producing different fusion profiles that could affect the structural capacity of the specified connection

C. Engineering approval is required — the H8 designation places the electrode in a different strength classification under CSA W48, and the drawing specification for E480XX cannot be satisfied by any electrode carrying a suffix designation that was not explicitly listed in the connection design specification

D. Substitution is not permitted — the hydrogencontrolled H8 designation changes the deposition efficiency of the electrode by approximately 15% compared to standard E480XX, requiring the designer to recalculate the minimum weld size to maintain the equivalent throat for the moment connection

44. A fabricator is completing fillet welds joining a 50 mm thick Grade 350W gusset plate (CE = 0.42) to a W310×143 column flange in a highly restrained configuration. The CSA W59 preheat table specifies 50°C minimum, but the welding engineer adds a note requiring 100°C for this specific joint. What is the technical justification for the elevated requirement?

A. The elevated preheat ensures the column flange is at sufficient temperature before the gusset fillet welds are started — heavy W sections retain significantly less heat than plate material of equivalent thickness and require 100°C minimum to prevent cold lap discontinuities at the fusion boundary between the gusset and flange

B. The elevated preheat accounts for the additional cold cracking risk created by the high joint restraint — elevated restraint increases the tensile residual stress in the HAZ during cooling, and the 100°C preheat provides a slower cooling rate through the martensite transformation range and additional time for diffusible hydrogen to escape the weld zone before the joint reaches ambient temperature

C. The elevated preheat is mandated by the base metal code because Grade 350W at 50 mm thickness automatically requires 100°C under CSA W59 Table 5.4 — the engineer's note is simply directing the fabricator to a specific table row that was overlooked in the general preheat chart used in the fabrication plan

D. The higher preheat is required to prevent lamellar tearing in the gusset plate — lamellar tearing is triggered by the throughthickness stress from the gussettocolumn weld, and maintaining the gusset at 100°C minimum prevents the plate from contracting through the critical temperature range where MnS inclusion planes are susceptible to throughthickness fracture

45. Under ASME B31.3 Process Piping, a circumferential butt weld made without any postweld examination receives a weld joint quality factor (E) of 0.80 rather than 1.00. How does this reduced E factor affect the design of the piping system?

A. The E factor affects only the required PWHT temperature — a joint quality factor below 1.00 requires a higher PWHT temperature to achieve the equivalent metallurgical condition of an examined joint at the same stress level

B. The E factor affects only the weld inspection frequency for subsequent inservice inspections — a lower E factor triggers more frequent NDE at scheduled inspection intervals but does not change the initial pipe wall thickness calculation

C. The E factor appears directly in the design equation for minimum pipe wall thickness — a lower E factor of 0.80 requires either increased wall thickness or reduced maximum allowable operating pressure compared to an E = 1.00 examined weld, because the design must account for the statistically higher probability of undetected weld defects when examination is omitted

D. The weld joint quality factor has no direct effect on the wall thickness calculation — it is a quality assurance classification factor that governs which inspection plan must be followed during fabrication but does not appear in the pressure design equation under ASME B31.3

46. After completing all welding and NDE on a pressure vessel designed to ASME Section VIII Division 1 with a maximum allowable working pressure of 3,500 kPa, a hydrostatic pressure test is required. What minimum test pressure applies, and why must it exceed the design MAWP?

A. Minimum hydrostatic test pressure = 1.3 × MAWP = 1.3 × 3,500 = 4,550 kPa — the hydrostatic test at 130% of MAWP verifies the structural integrity of the vessel, weld joints, flanges, and nozzles under pressure loads exceeding the design maximum, confirming no leaks, yielding, or deformation occur before the vessel enters service

B. Minimum hydrostatic test pressure = 1.5 × MAWP = 5,250 kPa — ASME VIII Division 1 specifies a 150% test factor for all vessels operating above 3,000 kPa, with the higher factor reflecting the elevated stored energy in highpressure vessels

C. Minimum hydrostatic test pressure = 2.0 × MAWP = 7,000 kPa — a doubleMAWP hydrostatic test is required for all vessels that store compressed gas rather than liquid, since gas stores significantly more energy per unit volume and the test must verify containment at twice the design pressure

D. Minimum hydrostatic test pressure = MAWP = 3,500 kPa — the proof test pressure equals the design pressure because the test is intended only to confirm no leaks at the operating condition rather than testing the vessel above its intended service parameters

47. During structural repair work, a welder must deposit a new fillet weld that terminates on top of an existing structural fillet weld at a connection node. What quality concern must be specifically addressed at the termination point?

A. The new fillet weld must terminate a minimum of 50 mm before reaching the existing weld — all welding codes prohibit continuation of new welds onto existing weld metal because the hardness differential creates a mechanical crack plane at the fusion interface between old and new weld metal

B. Standard crater fill technique is all that is required — new weld terminations on existing weld metal do not need any special handling because the existing weld provides thermal ballast that prevents the crater cracking that normally occurs when terminating on base metal

C. The existing weld must be ground to a feathered transition before the new weld terminates on it — the sharp edge at the end of the existing weld creates a stress concentration at the interface, and grinding a smooth transition is required before the new weld's toe can be acceptable at this location

D. The arc must not be extinguished directly at the sharp interface between the new and existing weld metal — the termination point creates a geometric notch where the deposited new bead meets the hardened existing bead; the crater must be filled and tapered to blend smoothly with the existing weld surface rather than ending abruptly at the contact point

48. A pressure vessel fabrication uses a weld map system with unique joint numbers. The traveller for Joint PV112 records: WPS WPSSS003, Welder ID W0019, Preheat 100°C confirmed, Electrode Heat Number H20234421, PT Accepted by Inspector I07. In the event of a postservice failure analysis, which traveller entry provides the direct chain of traceability to the specific lot of electrode and its manufacturer's quality records?

A. The WPS number WPSSS003 — the welding procedure specification references the specific electrode classification used, and the electrode manufacturer's certificate of conformance for that classification provides the batch composition data relevant to any failure analysis

B. The electrode heat number H20234421 — this lot number uniquely identifies the manufacturing batch of electrodes used at joint PV112, allowing direct retrieval of the electrode manufacturer's chemical composition certificate, mechanical test records, and diffusible hydrogen test results for this specific production lot

C. The PT acceptance record from Inspector I07 — the penetrant test report contains the surface evaluation data that correlates the root cause of any failure to the weld surface condition at the time of acceptance, providing the most direct failure analysis traceability

D. The welder ID W0019 — the welder's qualification record links directly to the procedure qualification test records, from which the electrode lot used during the original PQR qualification can be identified and compared to the production electrode chemistry

49. A pipe fabricator must cut three pieces each exactly 650 mm long from a single 2,000 mm length of structural pipe using a plasma arc system that produces a 4 mm kerf. How many cuts are required, what is the total kerf loss, and can the three pieces be obtained from this single length?

A. Three cuts are required, total kerf loss = 3 × 4 = 12 mm; material required = 3 × 650 + 12 = 1,962 mm; since 1,962 mm < 2,000 mm, the three pieces can be cut with 38 mm remaining

B. Four cuts are required including two endpreparation cuts; total kerf loss = 4 × 4 = 16 mm; material required = 1,966 mm; the three pieces can be obtained but the calculation must account for all cuts including the end preparations before material is committed

C. Two cuts are required to divide one length into three pieces; total kerf loss = 2 × 4 = 8 mm; material required = 3 × 650 + 8 = 1,958 mm; since 1,958 mm is less than 2,000 mm, the three 650 mm pieces can be produced from the single pipe length with 42 mm remaining

D. Two cuts are required; however, the kerf applies to each cut face rather than each cut, so total kerf loss = 4 cuts faces × 4 mm = 16 mm; the required material is 1,966 mm, which exceeds the available 2,000 mm when the six end preparation cuts are also factored in

50. An OFC operator must cut 50 mm thick 4140 alloy steel (CE = 0.85) for a structural component. This material airhardens in the HAZ during thermal cutting due to its high carbon equivalent. What precut and postcut protocol reduces the risk of HAZ cracking?

A. Preheat the plate to 200250°C before cutting, maintain this temperature throughout the cutting operation, and slowcool the cut piece after cutting using an insulating blanket — this reduces the thermal gradient and slows the HAZ cooling rate through the martensite transformation range, minimizing hardening and preventing the thermallyinduced cracking that occurs in highCE steels when allowed to aircool freely after OFC

B. Apply antispatter compound to the cut line before OFC and increase the preheat flame size to the maximum for the tip — the antispatter compound creates a barrier against rapid oxidation of the HAZ and the larger flame presoaks the plate to reduce the cooling rate gradient through the cut zone

C. Increase cutting oxygen pressure by 25% above the standard setting for lowcarbon steel of the same thickness — the higher cutting speed from increased oxygen pressure reduces the total thermal exposure time of the HAZ and minimizes the throughhardening depth

D. Apply a water quench along the cut line immediately as the torch passes — rapid water quenching prevents the martensite transformation from completing by cooling the HAZ through the martensite start temperature faster than carbon redistribution can occur

51. A fabricator must cut 6 mm thick copper plate into precision blanks. The shop has an oxyfuel outfit and a plasma arc cutter. Which process should be used for copper, and why does the other fail?

A. OFC is the correct process — copper oxidizes readily in the presence of oxygen and the copper oxide formed during OFC provides sufficient exothermic energy to propagate the cutting reaction through the full plate thickness just as iron oxide sustains carbon steel cutting

B. PAC is the correct process — OFC cannot cut copper because copper's extremely high thermal conductivity (approximately 400 W/m·K versus 50 W/m·K for steel) dissipates heat from the cutting zone far faster than the iron oxidation reaction can supply it, preventing the cutting reaction from sustaining; PAC uses arc energy independent of the metal's oxidation chemistry and cuts copper despite its thermal conductivity

C. Neither process can reliably cut copper in a standard shop — copper's combination of high thermal conductivity and high reflectivity prevents both OFC and PAC from establishing the localized cutting reaction needed to produce clean edges; waterjet or laser cutting is required for all copper plate applications

D. OFC produces the best results on copper because the copper oxide formed during cutting has a lower melting point than metallic copper, allowing the cutting oxygen stream to carry it away efficiently in a process mechanically identical to the slagremoval mechanism in carbon steel OFC

52. During mechanized PAC production on stainless steel, cut edges consistently show a negative bevel angle — the top of the kerf is wider than the bottom, creating an inverted taper. Which operating parameter most directly causes this negative cut angle?

A. Travel speed too fast — excessive travel speed causes the plasma arc to lag behind the nozzle position, producing a trailing angle at the cut face that registers as a wider top entry when measured with a bevel gauge

B. Amperage too low — insufficient arc power causes the plasma column to expand and diverge before reaching the plate, creating a coneshaped energy distribution that deposits more heat at the top entry surface and produces the widertop, narrowerbottom kerf geometry

C. Standoff distance too close — reducing the torchtoplate distance below the minimum concentrates plasma energy too close to the top plate surface, melting more material at the entry point and creating the wider top kerf associated with negative bevel angle

D. Standoff distance too large — when standoff exceeds the specified range, the diverging plasma jet spreads before contacting the plate surface, delivering more energy to the wide entry zone at the top than at the narrower bottom of the kerf, producing the negative taper that is the characteristic defect of excessive standoff distance

53. An OFC operator selects Tip No. 4 (rated maximum 75 mm) to cut 75 mm thick structural plate. A Tip No. 5 (rated 75100 mm) is also available. What is the expected performance difference when using Tip No. 4 at its maximum rated thickness versus Tip No. 5?

A. Tip No. 4 at its maximum rated thickness will produce acceptable cut quality but with minimal operating margin — the orifice delivers the minimum adequate cutting oxygen volume for 75 mm plate, leaving no tolerance for slightly elevated travel speed, lower than optimal gas pressure, or other nonideal conditions that would cause quality degradation with the undersized tip

B. Tip No. 4 is unable to cut 75 mm plate under any conditions — using a tip at its stated maximum rating always results in immediate reaction failure at the top surface because the oxygen volume from the maximumrated orifice is insufficient to initiate the cutting reaction at full plate thickness

C. Tip No. 4 will cut 75 mm plate faster than Tip No. 5 — the smaller orifice in Tip No. 4 maintains higher cutting oxygen velocity at the same regulator pressure, producing a more concentrated cutting stream that achieves faster oxidation and higher travel speed than the larger Tip No. 5 orifice

D. Both tips produce identical cut quality on 75 mm plate — tip ratings are conservative by design and any tip within one size of the required rating produces equivalent cut quality at identical parameters, making the tip selection purely an equipment availability decision

54. A CACA operator must gouge a repair channel 12 mm wide by 8 mm deep in structural carbon steel. Using the guideline that groove width approximately equals electrode diameter, which electrode diameter should be selected?

A. 6.4 mm — the correct electrode is selected at onehalf the specified groove width, and the groove is widened to the full 12 mm specification through two overlapping passes using the 6.4 mm electrode positioned at halfdiameter offsets per pass

B. 16 mm — the electrode diameter is selected to be larger than the specified groove width to account for resolidification on the sidewalls that reduces the finished width below the electrode diameter during normal gouging operations

C. 12 mm — applying the guideline that groove width approximately equals electrode diameter, a 12 mm electrode is selected to produce the 12 mm wide groove in a single pass; the 8 mm depth is achieved through the combination of amperage and travel speed settings

D. 8 mm — the electrode diameter must match the required groove depth rather than the groove width — the electrode arc penetrates to a depth equal to the electrode diameter, and the 8 mm depth specification is the governing dimension for electrode selection in CACA operations

55. A maintenance welder attempts to cut a cast iron machine housing using a standard oxyfuel cutting torch. Despite correct preheat procedures and tip selection, the cutting reaction fails to propagate beyond the top surface. Why does OFC fail on cast iron?

A. OFC fails on cast iron because the cutting oxygen pressure required to cut cast iron is three times higher than the maximum rated pressure of standard oxyfuel equipment — a highpressure regulator capable of delivering 1,000 kPa minimum cutting oxygen is required before any cutting reaction can be initiated on cast iron materials

B. OFC cannot cut cast iron by the normal iron oxidation mechanism because the high silicon content (13%) in cast iron forms silicon dioxide (SiO_2) at the cutting front — SiO_2 has a melting point of approximately 1,700°C, which is above the iron ignition temperature; the refractory silica slag solidifies before it can be expelled from the kerf and physically blocks the cutting reaction from penetrating the material

C. OFC on cast iron is successful only when the material is uniformly preheated to 650°C throughout its crosssection before cutting begins — the standard welding preheat of 200300°C used for cast iron is insufficient for OFC initiation and the apparent failure is caused by insufficient preheat rather than any fundamental cutting incompatibility

D. Cast iron fails to support OFC because its lower thermal conductivity compared to carbon steel prevents the preheat flame from heating the cutting zone to ignition temperature — selecting a cutting tip two sizes larger provides the additional preheat flame volume needed to overcome the thermal conductivity limitation

56. During mechanized PAC production, cut quality gradually deteriorates starting at approximately cut 200 — edges become less perpendicular and dross becomes harder to remove — even though the scheduled consumable replacement is at 250 cuts. What does this early deterioration indicate?

A. The gradual quality change beginning before the scheduled replacement interval indicates the consumables are wearing faster than the nominal specification for these specific operating conditions — the scheduled replacement count is a guide based on manufacturer testing conditions, not a guarantee; actual wear rate depends on material type, thickness, amperage, and cycle frequency, and the operator should replace consumables now rather than waiting for the predetermined count

B. Early quality deterioration between 200 and 250 cuts is within the expected variation range for PAC consumables — manufacturers set replacement intervals to begin where quality first shows measurable decline, and the early deterioration is confirmation that the consumable life prediction is accurate for this setup

C. Quality deterioration confirms the consumables are performing within specification — replace at exactly 250 cuts as planned, since the manufacturer's interval represents the point of optimal replacement based on the costversusquality curve for this consumable type

D. Gradual quality deterioration is always caused by incorrect standoff distance rather than consumable wear — the THC system must be recalibrated before considering consumable replacement, since premature replacement without correcting the root cause produces the identical deterioration pattern on the new consumables

57. An OFC operator must make cuts in large structural steel sections at an elevation of 8 metres above grade. Several other workers are completing tasks directly below the cutting area. What additional hazard controls beyond standard groundlevel OFC safety apply to this elevated cutting operation?

A. Oxygen and fuel gas cylinders must be located on the same elevated platform as the operator — regulations prohibit routing gas hoses vertically over 3 metres because the static head pressure from the vertical column exceeds the cylinder pressure limitation for standard OFC hose assemblies

B. The cutting flame must be adjusted to a reduced size at elevated locations — convective cooling from the vertical height increases heat loss from the torch tip and the preheat flame must be enlarged, not reduced, to maintain the required cutting temperature; using reduced flame actually introduces a new hazard from insufficient preheat

C. No additional controls are required beyond standard OFC safety procedures — the elevation itself introduces no new cuttingrelated hazards, and the same ventilation, PPE, and fire watch requirements apply identically at 8 metres as at ground level

D. A designated safety exclusion zone must be established below the cutting area with physical barriers to prevent personnel entry; a fire watch positioned at ground level must monitor for falling slag, sparks, and cut material; and a communication system must link the elevated operator with groundlevel personnel — the primary elevated OFC hazards are falling cutting byproducts and cut sections that present serious strike injury risk to personnel below

58. Following CACA excavation in a 316L stainless steel pressure vessel, an additional surface preparation step is required before MT inspection and repair welding. What is this step and why is it specifically required for stainless steel?

A. Passivation using dilute nitric acid — the passivation treatment neutralizes residual chromium oxide scale from the CACA thermal cycle and restores the passive surface layer before MT is applied, preventing particle adhesion that creates false indications

B. Application of antiflux compound followed by thorough removal — the antiflux prevents copper contamination from the electrode from entering the fluorescent MT particle suspension, which would contaminate the inspection bath and produce false particle accumulations throughout the examination zone

C. Mechanical grinding to remove at least 12 mm of material from the groove surface — the CACA carbon electrode deposits carbon into the groove surface through arc diffusion, creating a carbonenriched layer; grinding removes this contaminated layer and exposes clean stainless base metal with the correct lowcarbon chemistry for the Lgrade repair weld deposit

D. Wire brushing with a stainless steel brush only — carbon steel wire brushes embed carbon steel particles into the groove surface that cause galvanic corrosion at the repair location in service; only a dedicated stainless steel brush may be used for any postgouge cleaning on stainless steel surfaces

59. An OFC operator cuts 6 mm mild steel plate with parameters optimized for 25 mm plate. The cut quality is poor with irregular kerf edges, excessive melting of both faces, and distorted geometry. What technique adjustment prevents this on thin plate?

A. Increase the preheat flame to the maximum available size for the tip — thin plate requires proportionally more preheat energy relative to its crosssection to compensate for the rapid heat loss through the thin section, and the large preheat flame provides the sustained preheating needed for the cutting reaction to propagate evenly

B. Increase travel speed significantly above the thickplate setting — parameters optimized for 25 mm plate apply too much cumulative heat per unit length to thin plate, allowing heat to spread and melt the kerf faces irregularly; faster travel speed for thin plate limits the heat input per unit length and produces a cleaner, more controlled cut

C. Use a tip one to two sizes smaller than the plate thickness rating — reducing the tip size limits the cutting oxygen volume, preventing the thermal spread in the thin plate that causes the irregular kerf while still providing adequate oxygen for the thinner crosssection

D. Decrease the cutting oxygen pressure by 50% from the thickplate setting — the lower oxygen pressure reduces the oxidation energy intensity that causes thermal runaway and meltback on thin plate, preventing the kerf from widening irregularly below the intended cut line

60. A fabrication shop is evaluating installation of a water table below their mechanized PAC system. Which combination of benefits best justifies the capital investment?

A. The water table suppresses fume and particulate emissions by capturing cutting byproducts below the plate surface, significantly reduces noise levels from the plasma cutting process, cools the cut plate to reduce thermal distortion, and controls the travel of sparks and slag beneath the work — addressing occupational health, hearing hazard, dimensional quality, and fire risk in a single integrated system

B. The water table increases cutting speed by providing continuous nozzle and electrode cooling during the cutting cycle, allowing higher amperage operation and faster travel speed without exceeding consumable thermal limits, which is the primary productivity justification for the capital cost

C. The water table provides supplemental electrical grounding for the plasma power source by distributing the cutting return current through the water medium uniformly across the full plate contact area, which eliminates the arc blow that affects large plate cuts when contactpoint return connections are used

D. The water table enables cutting of aluminum, titanium, and highnickel alloys that cannot be reliably cut in air because these materials require the chemical reactions between the water and the molten metal surface to initiate and sustain the plasma cutting arc

61. Before using an oxyfuel cutting torch after a oneweek idle period, what specific preparatory step ensures safe operation and prevents a potentially dangerous condition in the hose system?

A. Connect the oxygen supply only and run oxygen flow for 30 minutes before connecting the fuel gas — the extended oxygen flush clears condensed moisture from the oxygen regulator and prevents any fuel gas from entering the oxygen circuit when the fuel connection is subsequently made

B. Light the torch immediately upon confirming both regulator gauges show working pressure — immediately lighting the torch verifies that both circuits are sealed and functional and confirms there are no internal blockages that would indicate hose deterioration during storage

C. Perform a complete leak test on all fittings using soap solution before lighting the torch — the leak test confirms all connections made after the idle storage period are gastight, preventing flammable gas accumulation near the work area when the system is first pressurized

D. Purge each hose separately before lighting — open the oxygen needle valve briefly to purge air from the oxygen hose, then close it and open the fuel gas needle valve briefly to purge air from the fuel hose; purging both circuits with their own gas before lighting prevents airfuel mixtures from forming inside the hoses that could create explosive conditions when the torch is relit

62. An OFC operator assesses the quality of a completed cut through 40 mm structural plate. The drag lines show a 4 mm backward sweep at the bottom edge. The top cut edge is sharp with no rounding or melting, and the cut face surface is smooth and uniform throughout. How should this cut quality be assessed?

A. Substandard — any backward drag on plate thicknesses under 50 mm indicates the travel speed is too fast and must be reduced by at least 20% to bring the drag lines to a vertical orientation regardless of the overall cut surface condition

B. Unacceptable for weld preparation use — a 4 mm drag sweep on 40 mm plate represents a 10% deviation from vertical that will produce a bevel on the cut face that must be ground flat before the edge can be used as a groove weld preparation surface

C. Acceptable cut quality for standard structural applications — a 4 mm backward drag on 40 mm plate is 10% of plate thickness, within the normal range for OFC cut quality on structural steel; the sharp top edge and smooth, uniform cut face confirm that the preheat, travel speed, and oxygen pressure are all within appropriate ranges for this plate thickness

D. Unacceptable from insufficient cutting oxygen — a smooth cut face combined with backward drag indicates reduced cutting oxygen delivery that prevents fulldepth penetration; smooth appearance at the top with drag below confirms the oxygen stream is marginal and the pressure must be increased until the drag lines become vertical

63. A PAC operator must cut 12 mm aluminum plate to produce edges that will be welded without grinding. Three shielding gas options are available: compressed air, nitrogen, and argon/35% hydrogen (H35). Which gas combination produces the cleanest, most weldready edge on aluminum?

A. Compressed air — air provides the highest cutting speed on aluminum among the three options and produces edges with minimal surface contamination since the nitrogen component of air prevents significant aluminum oxide formation during the short time the cut surface is exposed to the plasma arc

B. Argon/H35 — this blend produces the highest plasma temperature and enthalpy on aluminum and generates a bright, lowoxide cut edge due to the reducing hydrogen atmosphere in the plasma column; the hydrogen component minimizes aluminum oxide formation at the cut surface, producing a clean, metallurgically sound edge that can be welded with minimal surface preparation

C. Nitrogen — nitrogen is the most economical gas for aluminum cutting and produces cut edges with minimal nitrogen absorption into the aluminum lattice compared to air plasma, preventing the nitrogen embrittlement that can reduce weld joint toughness in the HAZ of plasmacut aluminum

D. Pure argon — argon's complete chemical inertness produces the most oxidationfree cut surface on aluminum of any available gas; the total absence of reactive components in the plasma column prevents all chemical interactions at the cut face, producing the cleanest edge available from any plasma gas combination

64. A multiflame OFC tip produces four normal neutral preheat flames and one flame with a white feather extending beyond its inner cone. What does the single abnormal flame indicate, and what action is required before cutting begins?

A. The single orifice with an extended feather is receiving less oxygen flow than the four normal orifices — a partial blockage at that specific orifice reduces its oxygentoacetylene ratio, creating a locally carburizing condition at that flame while the others remain neutral; the blocked orifice must be cleared with a correctly sized tip cleaner and the flame pattern verified before cutting begins

B. The extended feather on one orifice indicates the oxygen supply pressure has dropped below the tip's minimum operating requirement — a single abnormal orifice is the first visible indicator of supply pressure deficiency before the effect spreads to all five orifices, and the regulator must be adjusted before cutting proceeds

C. The single extended feather is a normal operating variation produced during the initial tip warmup period and will selfcorrect within 5 minutes of continuous operation — no action is required since multiorifice tips exhibit this transient flame variation until the tip body reaches uniform operating temperature

D. The single abnormal orifice has a microfracture in the tip body from thermal fatigue — the fracture allows acetylene to bypass the orifice exit and mix externally, producing the visible white feather; the tip must be discarded and replaced since a cracked tip body cannot be safely cleaned or repaired

65. During mechanized PAC production, the arc extinguishes at the midpoint of a cut in 20 mm carbon steel plate. What is the correct restart procedure to prevent consumable damage and restore cut quality through the interruption point?

A. Return the torch to the cut start and make a new cut along the same path — restoring a clean, fullkerf geometry requires starting fresh from the plate edge, as the plasma arc cannot reliably reestablish through the partiallyhardened material at the interruption point without special procedures

B. Position the torch directly above the interruption point and restart the arc immediately in the open kerf — the existing kerf provides an open path for the transferred arc to reestablish directly at the midcut position without requiring any position offset

C. Position the torch 3 to 5 mm before the interruption point along the completed cut section, restart the arc in the open kerf there, allow the transferred arc to stabilize fully, then advance through the interruption point and continue the cut in the programmed path

D. Advance the torch 20 mm past the interruption point into the uncut material before restarting — the additional uncut material ahead of the interruption zone allows the arc to reach full cutting temperature and stable parameters before encountering the thermally affected zone at the interruption site

66. When connecting new oxygen and fuel gas hoses to an oxyfuel cutting torch system for the first time, what is the correct hose purging sequence before lighting?

A. Open both cylinder valves simultaneously and then both torch needle valves simultaneously — concurrent purging prevents any sequential crosscontamination between the two circuits that might occur during separate purging if check valve performance is marginal

B. Purge the fuel gas hose first before the oxygen — establishing the fuel gas atmosphere in its hose before the oxygen is introduced prevents oxygen from entering the fuel circuit through diffusion during the initial pressurization step

C. No purging is required for new hoses — new hoses are shipped in gastight sealed condition from the manufacturer, preventing air infiltration during shipping and storage, making immediate connection and lighting the recommended procedure

D. Purge each hose circuit separately with its own gas before lighting — briefly open the oxygen torch needle valve to fill the oxygen hose with oxygen, then close it; then briefly open the fuel needle valve to fill the fuel hose with fuel gas, then close it; this ensures each circuit contains only the correct gas before the torch is lit

67. A CACA operator must produce a consistent gouge depth of 8 mm ± 1.5 mm for a structural repair excavation. What two technique parameters most directly determine and control the groove depth throughout the operation?

A. Electrode diameter and compressed air pressure are the governing depth parameters — the electrode diameter sets the arc penetration radius and the air pressure determines the expulsion depth per pass; maintaining constant diameter and pressure produces repeatable depth independent of operator movement

B. Electrode angle from the work surface and travel speed are the primary depth control parameters — a steeper electrode angle produces deeper grooves and slower travel speed increases arc time per unit length, deepening the excavation; consistent maintenance of both parameters throughout the operation produces the required uniform depth

C. Amperage and electrode diameter together set a fixed groove depth for any given combination — higher amperage melts more material and larger diameter sustains the arc at greater depth, creating a predictable depth value from any amperagediameter pairing that the operator cannot independently adjust during gouging

D. Arc voltage is the sole depth control parameter — longer arc length (higher voltage) produces shallower grooves and shorter arc length (lower voltage) produces deeper grooves; the operator controls depth entirely by maintaining the electrodetowork distance at the specified operating voltage for the depth specification

68. A fabricator is cutting 10 mm 304L stainless steel for weldpreparation bevels using a dualgas PAC system with separate plasma gas and shielding gas circuits. Which gas combination minimizes cut edge oxidation and produces the most weldready surface?

A. Nitrogen plasma gas with nitrogen shielding gas — this combination produces a clean, bright cut edge on austenitic stainless steel with significantly less chromium oxide discoloration than air plasma; nitrogen provides good thermal cutting efficiency while protecting the cut face from oxidation during the cutting cycle

B. Air plasma gas with CO_2 shielding — CO_2 shielding reacts with chromium at the stainless cut surface to form stable chromiumCO_2 protective compounds that prevent further chromium oxidation during cooling after the plasma arc passes

C. Oxygen plasma gas with argon shielding — oxygen plasma provides the highest cutting speed on stainless steel and the argon shielding contains the surface oxidation to the top 2 mm of the kerf, protecting the lower cut face from chromium loss below this level

D. H35 argonhydrogen plasma with compressed air shielding — the H35 plasma produces the highest arc energy for stainless cutting while the compressed air shielding rapidly quenches the cut face through the chromium oxidation temperature range before significant oxide formation can occur

69. An OFC operator notices that the oxygen working pressure gauge slowly creeps upward from 350 kPa to 390 kPa over 5 minutes with both the cylinder valve closed and the torch needle valve closed. What does this indicate and what must be done?

A. The creeping pressure reading is caused by normal thermal expansion of the trapped oxygen in the hose as it warms from storage temperature to shop temperature — no action is required since pressure increase from ambient warming of a sealed gas volume is an expected physical response

B. The creeping pressure indicates the oxygen hose is permeable — oxygen from the shop atmosphere is diffusing through the hose wall into the sealed circuit; the hose must be replaced with a nonpermeable oxygenrated rubber hose before the system is returned to service

C. The creeping pressure indicates the oxygen regulator highpressure seat is leaking — gas from the highpressure side is bleeding past the delivery seat into the lowpressure delivery circuit despite the closed cylinder valve; the regulator must be removed from service and repaired by a qualified technician before any further use

D. The creeping pressure results from barometric pressure fluctuations during the measurement period — atmospheric pressure changes are transmitted to the sealed hose circuit through the semipermeable regulator diaphragm, producing the apparent pressure increase that correlates with local weather system changes in barometric pressure

70. At the end of a production shift, a mechanized dualgas PAC system must be shut down correctly. What is the proper shutdown sequence?

A. Turn off the power source first before closing any gas supply valves — removing the arc energy before gas flows cease prevents any residual ionized gas from sustaining an arc that might damage the nozzle if the power is left on during gas valve closure

B. Close all gas supply valves simultaneously before switching off the power source — removing the gas supply first ensures the electrode and nozzle cool without the arc energy that would continue to heat them during a poweronly shutdown

C. Vent all pressurized gas from both circuits through the torch nozzle before closing any valves — fully depressurizing both gas circuits before any valve manipulation prevents pressuresurge damage to the regulator diaphragms during the cold storage period

D. Complete the final production cut, allow the postcut cooling gas flow cycle to run completely to cool the torch body to safe temperature, then turn off the power source and close the gas supply valves — interrupting the shielding and cooling gas flow before the torch has cooled to safe temperature removes the gas cooling protection from the nozzle and electrode, accelerating thermal damage

71. A production shop must choose between acetylene and propane for a fleet of OFC torches used primarily for cutting 25100 mm structural plate in highvolume production. Which statement most accurately reflects the practical performance comparison for this plate thickness range?

A. Acetylene is superior for all production cutting applications above 20 mm — propane's lower flame temperature makes it unsuitable for any plate over 20 mm thickness, and the lower cutting speed of propane causes drag line curvature that fails structural cut quality requirements for plate above 30 mm thickness

B. Propane can achieve comparable cut quality to acetylene on structural plate above 12 mm when used with tips designed for propane's heat release profile — propane's higher heat content per cubic metre, lower cost per unit energy, and safety advantages from its lack of instability at working pressures make it economically competitive in highvolume structural plate cutting applications at these thicknesses

C. Acetylene and propane produce identical cut quality at all structural plate thicknesses above 6 mm — the only difference is fuel cost, and the selection should be made purely on delivered price per unit volume regardless of all other operational considerations

D. Propane is superior to acetylene for all structural plate above 6 mm because propane burns hotter than acetylene across the full secondary combustion zone, providing more distributed preheat energy over a larger area of the plate surface that is more effective for thick plate than acetylene's narrow, intense primary inner cone

72. Which statement most accurately describes the application characteristics and appropriate use of E6013 electrodes in comparison to E6011 and E7018 for structural steel welding?

A. E6013 electrodes produce a soft, stable arc with a fluid rutile slag that delivers excellent bead appearance and easy slag removal, making them wellsuited for light fabrication, sheet metal, and training applications; their key limitations for structural work are lower penetration than E6011 and higher diffusible hydrogen than E7018, making them inappropriate for thicksection or highrestraint joints where cold cracking risk is a concern

B. E6013 produces deeper penetration than E6011 at the same amperage because the rutile coating chemistry produces higher arc force — this makes E6013 the preferred choice for openroot structural pipe joints where maximum root penetration is the primary selection criterion

C. E6013 is classified as an allposition, lowhydrogen electrode under AWS A5.1 — the "13" suffix designates the hydrogencontrolled flux coating that distinguishes E6013 from the higherhydrogen E7016 and allows its use in highrestraint structural applications where cold cracking resistance is specified

D. E6013 electrodes are designed exclusively for AC power sources — the rutile coating chemistry requires alternating current to sustain stable arc operation; attempting to use E6013 on DC produces an unstable arc with excessive spatter because the basic flux components require the reversal cycles of AC to complete their ionization function

73. A welder must select an electrode and set amperage for a 3F (horizontal fillet) joint on 10 mm structural plate with a specified 8 mm fillet weld leg size. Following the guideline that electrode diameter should approximate onehalf the specified leg size for fillet welds, which electrode and amperage combination is most appropriate?

A. 2.5 mm E7018 at 70 A — the 2.5 mm electrode at minimum amperage is selected to achieve the controlled heat input needed to avoid angular distortion on the 10 mm plate when depositing an 8 mm fillet in the horizontal position

B. 6.4 mm E7018 at 320 A — the largest available electrode should always be selected for the highest deposition rate, and 320 A provides the heat needed for the 8 mm leg specification in the horizontal position with minimum arcon time

C. 4.0 mm E7018 at 150170 A — a 4.0 mm electrode diameter approximately equals onehalf the 8 mm specified leg size; 150170 A is within the standard operating range for 4.0 mm E7018 electrodes and provides appropriate heat input for the 3F position on 10 mm plate

D. 3.2 mm E7018 at 95 A — the 3.2 mm electrode at the minimum amperage ensures the tightest control of heat input and produces the most stable horizontal fillet weld pool on 10 mm plate, preventing the angular distortion that occurs with larger electrodes in this fillet application

74. A welder produces multiple SMAW passes on Type 304 stainless steel using E30816 electrodes and is warned by the supervisor about sensitization risk. What is sensitization in austenitic stainless steel, and how does controlling the maximum interpass temperature reduce the risk?

A. Sensitization is the permanent transformation of austenite to martensite in the weld metal caused by the repeated thermal cycling of multipass welding — the maximum interpass temperature prevents the weld metal from dropping below the martensite start temperature between passes, keeping the deposit austenitic throughout the complete joint

B. Sensitization is caused by sigma phase precipitating at austenite grain boundaries from prolonged exposure above 600°C — maintaining the interpass temperature above 600°C throughout the weld cycle prevents sigma phase nucleation by keeping the weld metal above the formation range during deposition

C. Sensitization occurs when excessive dilution from the base metal reduces the chromiumtoiron ratio below 11% in the weld deposit — controlling the maximum interpass temperature limits the number of passes that can be deposited per day, reducing the cumulative dilution across the multipass joint

D. Sensitization is the precipitation of chromium carbides ($Cr_{23}C_6$) at austenite grain boundaries when the steel is held in the temperature range of approximately 425870°C for extended time — the chromiumdepleted zones adjacent to the carbides are susceptible to intergranular corrosion; a maximum interpass temperature limit keeps the HAZ of successive passes from spending excessive time in this sensitization range

75. A structural welder is completing SMAW on 75 mm thick Grade 490W plate at 150°C minimum preheat. The supervisor asks why the minimum preheat must be maintained at the joint ends as the welder approaches the end of each pass, not just at the arc start. Which explanation is most technically accurate?

A. Maintaining preheat at the ends keeps the joint above the martensite transformation temperature throughout the full length — Grade 490W must never cool below 150°C at any location until the full crosssection thickness is deposited, since cooling below preheat between passes permanently reduces the steel's yield strength in those locations

B. Cold joint ends cool the deposited weld metal rapidly through heat conduction even while the arc is active at the trailing weld pool — a cold base metal ahead of the arc acts as a heat sink that can produce cooling rates at the weld end exceeding the threshold for martensite formation and hydrogen cracking in the alreadydeposited metal, regardless of whether the arc is still active nearby

C. Maintaining preheat at joint ends prevents magnetite formation on the weld surface — surfaces that cool below 150°C between passes develop an iron oxide scale classified as contamination under CSA W59, requiring interpass grinding at all end locations where the preheat temperature was not maintained

D. Preheat at joint ends is required only for the root and first fill pass — subsequent passes generate sufficient selfpreheat from the underlying weld metal that the joint ends remain within the acceptable temperature range without supplemental external heating

76. A maintenance welder must repair a cracked cast iron machine housing using ENiCI (pure nickel) electrodes. The repair weld is 200 mm long. Which technique is most critical for preventing cracking in the cast iron HAZ adjacent to the repair weld?

A. Deposit short stringer passes of 3040 mm maximum, peen each pass immediately after deposition while still warm, and allow each pass to cool to approximately 50°C before depositing the next — this combination of short passes, immediate stressrelief peening, and controlled interpass cooling minimizes thermal gradient in the brittle cast iron, controls HAZ martensite formation through the slow cooling, and uses peening to relieve the weld contraction stresses that would otherwise crack the lowductility base material

B. Deposit the full 200 mm weld in a single continuous pass at the maximum rated amperage for the electrode — the single highheat pass minimizes the number of fusion cycles in the cast iron HAZ and reduces total martensite content in the HAZ compared to multiple loweramperage passes

C. Preheat the casting to 650°C throughout the entire crosssection before welding and maintain 650°C throughout the full repair — ensuring the entire casting remains above the austenite transformation temperature throughout the weld cycle prevents any martensite formation in the HAZ of the 200 mm repair weld

D. Use a wide weave technique with maximum available weave width on each pass — the distributed heat pattern of wide weave beads prevents the localized temperature spike that creates white iron zones in cast iron HAZ, and the wide bead profile provides a more ductile fusion boundary geometry than narrow stringers

77. Visual inspection of a lot of E7018 electrodes reveals long longitudinal cracks running along the coating on some electrodes and spiral crack patterns on others. The core wire is visible through all the cracks. What quality concern does this cracked coating create for the weld deposit?

A. Cracked coatings create an unstable arc that extinguishes intermittently during welding — the cracks reduce the electrical conductivity of the flux sheath and interrupt the ionization path needed to sustain the arc between deposits, requiring higher opencircuit voltage to maintain arc stability

B. Cracked coatings on E7018 lowhydrogen electrodes are cosmetic defects only and do not affect weld quality — the cracks are caused by thermal cycling during storage, but the underlying flux chemistry and mechanical integrity of the electrode core are not compromised by the surface cracking pattern

C. Cracked coatings on E7018 electrodes compromise the moisture exclusion function of the intact coating — cracks expose the basic flux to atmospheric humidity, allowing moisture absorption that increases diffusible hydrogen above the Hclass limit and defeats the purpose of the lowhydrogen classification; cracked electrodes must be discarded or reconditioned according to the code maximum exposure requirements before use

D. Cracked coatings on E7018 electrodes are a diagnostic indicator of overdrying in the holding oven — excessively dried basic coatings develop the observed crack patterns when dried above the 430°C maximum reconditioning temperature, and these electrodes produce elevated weld metal porosity from microvoids in the overdried coating

78. A SMAW setup using E6010 electrodes and DC power produces an extremely unstable arc with heavy widedispersed spatter and very shallow fusion into the base metal. The amperage is confirmed at 130 A for a 3.2 mm electrode. What is the most probable cause?

A. The arc length is too long — at 130 A with E6010, an arc length exceeding 5 mm produces exactly the combination of instability, wide spatter, and shallow fusion described, and reducing to the standard 3 mm arc length will restore normal arc characteristics

B. The E6010 electrodes were stored in a heated oven at 100°C for 4 hours before use — oven storage damages E6010's cellulosic coating chemistry and causes the arc characteristics described when the electrode's moisturegenerating capability is reduced

C. The travel speed is too fast — at 130 A with 3.2 mm E6010, travel speed above 300 mm/min produces the described shallow fusion and wide spatter, and reducing travel speed restores the deeppenetrating arc characteristics of the cellulosic electrode

D. The power source polarity is set to DCEN (electrode negative) rather than the required DCEP (electrode positive) — E6010 electrodes are designed and classified for DCEP polarity, and operation on DCEN produces the characteristic combination of unstable arc, reduced penetration, and wide globular spatter described

79. A pipe welder completing a root pass on 6inch NPS Schedule 80 pipe in the 5G position using E6010 electrodes consistently produces lower insidediameter root reinforcement at the 3 o'clock position compared to the 6 o'clock and 12 o'clock positions. What technique adjustment specifically addresses the 3 o'clock deficiency?

A. Reduce the arc length at the 3 o'clock position to counteract the arc blow effect — work lead arc blow is strongest at the side positions due to the asymmetric return current path, and the shorter arc prevents the deflection that reduces root penetration at 3 o'clock

B. Pause the electrode travel at the 3 o'clock position and use a brief oscillating motion to build additional heat and weld metal at that specific location — gravity acts laterally at the 3 o'clock position, tending to pull the keyhole asymmetrically; the pause and oscillation compensates by directing additional arc energy to reestablish and maintain root penetration before travel resumes

C. Increase the amperage by 20 A specifically for the 3 o'clock segment — the plate mass at the side positions creates a localized heat sink that reduces penetration, and the higher amperage compensates by forcing more energy through the root gap at the 3 and 9 o'clock locations

D. Switch from uphill to downhill travel direction for the 3 o'clock segment only — changing direction at this position redirects the arc force from upwardintoroot to downwardintoroot, improving keyhole formation specifically at the location where gravityrelated penetration deficiency is most prominent

80. A welded assembly on 30 mm thick structural plate shows longitudinal bowing after all multipass CJP groove weld passes were completed and the clamps were released simultaneously. The welding sequence was correctly executed. What is the most probable cause of the distortion occurring at clamp release?

A. Releasing all clamps simultaneously allows the accumulated longitudinal weld shrinkage to act at once — if the weld cooling was asymmetric along the joint (one end hotter at clamp release than the other), the differential shrinkage produces a bowing force that could not develop while the clamps provided end restraint; sequential clamp release or maintaining restraint through PWHT reduces this distortion mode

B. The multipass sequence deposited too many passes from one groove face before alternating — strict alternating of every single pass from the arrow side and other side of the joint is required for all thickplate multipass welds, and any deviation from this rigorous alternating sequence is the only cause of longitudinal bowing in properly restrained multipass applications

C. Longitudinal distortion in multipass thickplate welds results exclusively from the cap pass heat input — the cap pass shrinkage governs the final distortion state because subsequent passes cannot counteract it, and excessive cap pass heat input is the primary cause of the observed bowing condition

D. Longitudinal bowing in DC SMAW multipass welds is caused by magnetic arc blow — the cumulative unidirectional magnetic force from the work lead position creates a progressive lateral force on successive passes that displaces the weld centerline and produces the bowing pattern when restraint is removed at clamp release

81. A container of E7018 H4 electrodes was left open and unsealed in the welding shop during a hot, humid summer day for an unknown period. The coating appears intact and no physical damage is visible. Under AWS D1.1, what options are available?

A. Return the electrodes immediately to a holding oven at 120°C for 24 hours — the 24hour lowtemperature drying cycle at the holding oven temperature fully restores E7018 H4 classification status regardless of the duration of the prior atmospheric exposure

B. The electrodes may be used immediately — E7018 H4 electrodes are classified with an extended atmospheric exposure tolerance and do not require any reconditioning for any duration of summer shop exposure at standard manufacturing facility humidity levels

C. Recondition the electrodes by heating them in a reconditioning oven at 260430°C for a minimum of 1 hour — reconditioning at the specified elevated temperature drives absorbed moisture from the basic coating and is required before these electrodes may be used for structural welding covered by the code;

the number of reconditioning cycles permitted before disposal follows the electrode manufacturer's specific guidance

D. The electrodes must be discarded entirely — any E7018 electrode with unknown atmospheric exposure duration can never be restored to its original hydrogen classification through reconditioning and must be replaced with fresh sealed material regardless of the coating's visual condition

82. During SMAW with E309L16 electrodes on a dissimilar metal weld, the welding engineer requires the deposited weld metal to be maintained between 4 and 12 ferrite number (FN). What is the metallurgical basis for this specific FN range?

A. An FN below 4 means the deposit has insufficient electrical conductivity for the SMAW process — the weld deposit must maintain minimum delta ferrite content to sustain the arc stability characteristics of the E309L coating system and prevent arc extinction during deposition

B. An FN above 12 indicates the deposit will transform to sigma phase within 5 years of ambient temperature service — controlling to 12 FN maximum prevents the premature sigma phase embrittlement that would occur in deltaferriterich deposits in ambienttemperature structural service within the design service life

C. FN below 4 indicates the weld deposit has insufficient base metal dilution — the FN measurement confirms that the carbon steel base metal has contributed adequate iron to the deposit to meet the minimum alloy content required by the design specification

D. Delta ferrite in the 412 FN range prevents solidification hot cracking — a fully austenitic deposit solidifies through a singlephase path that concentrates lowmelting impurities at grain boundaries; the presence of delta ferrite disrupts this segregation mechanism during solidification, interrupting the continuous liquid film at grain boundaries that enables hot cracking under solidification contraction stresses

83. A maintenance welder must weld a cracked 4140 alloy steel shaft that is quenched and tempered to 48 HRC using E12018M electrodes. What PWHT after welding most appropriately addresses both the cold cracking and mechanical property concerns?

A. No PWHT is required — the E12018M electrode classification guarantees the deposited weld metal is inherently resistant to hydrogen cracking, and the electrode's certified low hydrogen content alone prevents cold cracking in the 4140 HAZ regardless of the existing base metal hardness

B. Stress relief at approximately 600650°C, performed below the original 4140 tempering temperature of approximately 650700°C, is the recommended postweld treatment — this temperature range reduces residual welding stresses and tempers hard martensite in the HAZ without significantly overtempering the existing Q&T base metal strength below the service requirement

C. Full reheat treatment by requenching and retempering is the only acceptable PWHT for any weld on 4140 steel above 40 HRC — partial stress relief is not accepted by any welding code for quenchedandtempered steels in this hardness range, and the weld must be fully reheat treated to original specification before returning to service

D. PWHT at 730°C for 1 hour per 25 mm of shaft diameter is mandated by ASME B31.1 for all welds on alloy steel above PNumber 3 classification — this temperature and hold time ensures complete martensite tempering and full stress relief in any alloy steel component regardless of the original heat treatment condition

84. A SMAW welder operating a constantcurrent droopingcharacteristic power source at 140 A notices a more stable arc and wider operating range when the opencircuit voltage (OCV) is increased from 65 V to 80 V. How does this OCV increase affect the welding process?

A. Increasing the OCV on a CC machine primarily affects the arc stability margin and the maximum arc length at which a stable arc can be sustained — a higher OCV makes arc initiation easier and extends the arc length range before extinction, but does not significantly change the welding amperage at a given arc length since the operating point is determined by the intersection of the machine's drooping VA characteristic with the arc load line, not by the OCV alone

B. Increasing the OCV on a CC machine directly increases the welding amperage proportionally — an increase from 65 V to 80 V represents a 23% increase in available circuit voltage that raises the welding current from 140 A to approximately 172 A through the linear relationship described by Ohm's law for the welding circuit

C. Increasing OCV causes the machine to transition from CC to CV characteristic — the voltage increase shifts the machine's output characteristic from the drooping SMAWsuitable mode to the flat GMAWsuitable mode, requiring the operator to reselect the operating mode before continuing

D. Increasing OCV has no operational effect once the arc is established — OCV is relevant only at the instant of arc initiation, and all welding parameters including voltage and amperage are governed exclusively by the physical arc length after the arc is established

85. A welder is preparing to weld a structural joint on galvanized steel angle iron where the zinc coating is still intact at the weld preparation area. Which preparation procedure and rationale correctly applies to this situation?

A. The galvanized coating may be removed only from the direct weld zone using OFC flame burning — playing the cutting torch along the preparation area cleanly removes the zinc coating and the zinc oxide residue is carried away by the oxygen stream without leaving any surface contamination

B. No preparation is required — modern E7018 lowhydrogen electrodes contain flux chemistry specifically formulated to neutralize zinc coatings during welding, converting the zinc to a harmless compound retained in the slag layer rather than entering the weld metal or generating fumes

C. The galvanized coating must be removed by grinding, wire brushing, or chemical stripping before welding — zinc vaporizes at approximately 907°C (below welding temperatures), generating zinc oxide fumes that cause metal fume fever; additionally, zinc entering the weld pool can cause liquid metal embrittlement by penetrating grain boundaries in the HAZ, producing immediate cracks in the heataffected zone during the welding thermal cycle

D. No preparation is required — galvanizing improves weld joint performance by reducing porosity through the zinc's deoxidizing action in the weld pool; removing the coating before welding unnecessarily eliminates this metallurgical benefit and increases the oxidation of the base metal at the fusion boundary

86. A visual inspector finds that a completed structural SMAW fillet weld turns a sharp 90degree internal corner, and the weld toe at the inside of that corner shows a visible notch approximately 0.5 mm deep. Under CSA W59 requirements for statically loaded structures, what is the assessment?

A. Acceptable — 0.5 mm at a weld corner toe is a geometric artifact classified below the minimum rejectable 1.6 mm (1/16 inch) undercut depth specified in CSA W59 for all fillet welds on statically loaded structural connections regardless of the joint geometry

B. Acceptable with measurement documentation only — the 0.5 mm depth must be recorded in the inspection record; statically loaded fillet weld toe notches under 0.8 mm at inside weld corners require only dimensional documentation without requiring repair or engineering review

C. Conditionally acceptable — the 0.5 mm notch at a weld corner meets the CSA W59 insidecorner notch tolerance of 0.8 mm maximum for combined fillet weld lengths under 100 mm, but the total combined fillet length must be measured before the final accept decision is confirmed

D. Rejectable — the notch at the inside weld corner creates a geometric stress concentration that can initiate cracking, and on structural connections the weld must be executed to eliminate reentrant corner notches through smooth blending of the weld toe; the visible 0.5 mm notch must be repaired by filling and blending the corner transition to produce a smooth, notchfree profile

87. A certified welder discovers that the root gap in the CJP groove weld joint to be welded is 8 mm — 2 mm wider than the WPS maximum of 6 mm. Under production pressure, the supervisor suggests proceeding since the deviation is small. What is the correct professional response?

A. Proceed with welding using a short backandforth keyhole technique to bridge the 2 mm excess — experienced welders routinely accommodate root gap variations of ±2 mm through technique adjustment, and this field accommodation is universally accepted under structural and pressure vessel codes

B. Stop welding and report the nonconformance to the supervisor before any arc is struck — welding a joint preparation that does not conform to the WPS essential variables constitutes use of an unqualified procedure; the joint must be corrected to within the WPS limit, or an engineering disposition must formally authorize the wider gap before any production welding begins

C. Proceed with welding but record the actual 8 mm gap in the traveller — documenting the deviation in the production record under the welder's signature satisfies all code requirements and constitutes the authorized acceptance of the nonconforming condition

D. Contact the electrode manufacturer's technical representative for authorization — the electrode manufacturer can approve nonstandard root gap dimensions for E7018 electrodes since root gap tolerance is a consumable chemistry variable governed by the electrode specification rather than the welding code

88. A welder must select an SMAW electrode for welding Grade 91 (PNumber 5B, 9Cr1MoV) alloy steel pressure pipe that will operate at 565°C service temperature. Which electrode classification produces a deposit with the required elevatedtemperature creep properties?

A. E9018B3 — this electrode produces a 2.25Cr1Mo deposit that closely approximates the chromium and molybdenum content of Grade 91 and is the most commonly qualified electrode for all PNumber 5 chromemoly pressure pipe applications

B. E8018B8 — this electrode provides a 9Cr1Mo deposit that matches the base chromium and molybdenum content of Grade 91, and the B8 suffix identifies the base chemistry needed for elevatedtemperature service

C. E9015B9 or E9018B9 — the B9 designation specifically identifies filler metals whose chemical composition matches Grade 91 steel including the vanadium, niobium, and nitrogen additions essential for the precipitationhardening mechanism that provides Grade 91's elevatedtemperature creep strength; B9 filler metals are the coderequired choice for PNumber 5B Grade 91 welding

D. E7018 — standard carbon steel electrodes at the 70 ksi strength classification provide adequate ambienttemperature tensile properties for Grade 91 pipe, and the loweralloy deposit reduces the risk of overtempering at the PWHT temperature compared to the matchedalloy electrode options

89. A structural welding crew must complete outdoor SMAW fillet welds on a bridge girder at −15°C ambient temperature. The base metal (Grade 350W, CE = 0.40) has been preheated to 50°C per CSA W59. During welding, a strong cold wind begins blowing across the joint. What additional precaution is required?

A. Wind screens or enclosures must be erected around the weld area — cold wind increases the HAZ cooling rate beyond what the established preheat alone controls, causing the effective cooling rate to exceed the design basis of the preheat requirement even when the preheat temperature is actively maintained; wind protection is an engineering control that must be added to the cold weather preheat protocol when wind velocity creates unacceptable supplemental cooling

B. The machine amperage must be increased by 25% to compensate for the additional heat loss caused by the cold wind — the higher welding heat offsets the windinduced cooling without requiring the additional setup time and cost of wind enclosures

C. The preheat temperature must be increased to 100°C minimum when wind speed exceeds 20 km/h — CSA W59 Appendix B specifies mandatory preheat increases for each increment of wind speed above 15 km/h, with 100°C being the required minimum preheat for CE 0.40 material in these wind conditions

D. No additional precaution is needed — the preheating temperature of 50°C was established using the CSA W59 preheat table values that incorporate a builtin safety margin for cold outdoor welding, and wind has no measurable net effect on the weld HAZ cooling rate once the required preheat temperature is confirmed and maintained throughout the joint

90. A fabrication engineer compares E71T1M and E71T5M FCAWG wires for structural carbon steel welding on thicksection (50 mm) highlyrestrained connections where cold cracking risk is elevated. Which selection criterion most directly favors E71T5M?

A. E71T5M is preferred for thicksection work because its rutile slag system produces higher deposition rates than the basic slag system of T1M at equivalent amperage and voltage settings, reducing the total arc time required on the thicksection joints

B. E71T5M is preferred because it can be used without external shielding gas — T5 wire generates adequate shielding from its core flux compounds alone, reducing equipment and gas cost for all thicksection structural welding including outdoor applications

C. E71T5M and E71T1M produce identical mechanical properties and diffusible hydrogen — the selection is purely economic, and T5M should be chosen only when it is priced lower per kilogram than T1M for the same diameter

D. E71T5M produces lower diffusible hydrogen in the deposit than E71T1M — the basic (limebased) slag chemistry of T5 wire is analogous to the lowhydrogen E7018 SMAW electrode family and produces H8 or better hydrogen levels, making it the preferred choice when the combination of thick section and high restraint creates the elevated cold cracking risk that requires the lowest achievable diffusible hydrogen in the fusion zone

91. A GMAW welder using shortcircuit transfer on 1.6 mm sheet steel produces welds with cold laps and lack of fusion along the weld toe, despite bead profiles that appear acceptable from above. The voltage and wire feed speed are within the WPS range. What parameter adjustment addresses the cold lap deficiency in shortcircuit transfer GMAW?

A. Increase the wire feed speed significantly above the WPS maximum — cold laps in shortcircuit transfer result from insufficient metal deposition volume per unit length; increasing the wire feed speed above the WPS range forces more metal into the fusion zone and eliminates the cold lap condition

B. Increase the arc voltage slightly within the upper end of the WPS specification range — increasing voltage in shortcircuit transfer lengthens the arc slightly, delivers more heat to the weld toe area before each short circuit event occurs, improves pool fluidity at the toes, and reduces cold lap formation without causing arc instability if the adjustment remains within the WPS operating band

C. Reduce the CO_2 content in the shielding gas from 25% to 5% CO_2 — elevated CO_2 in standard 75/25 Ar/CO_2 creates excessive arc force that pushes the pool ahead of the fusion zone; reducing the CO_2 to 5% restores the correct arc force for the pooltofusionzone relationship that prevents cold lap

D. Reduce the CTWD to 6 mm — shortcircuit transfer requires the minimum possible stickout to ensure wire contact with the molten pool before arc formation; a 6 mm CTWD is required for cold lap prevention on all material under 2 mm regardless of other parameter settings

92. A GMAW operator producing flatposition structural steel welds with ER70S6 and 75/25 Ar/CO_2 is in the globular transfer mode with heavy spatter. To transition to spray transfer, what specific parameter change is required?

A. Reduce the wire feed speed until the amperage drops below the minimum spray transition current — spray transfer occurs at lower amperages than globular, and reducing the wire feed speed to drop the amperage is the only parameter change needed

B. Change the shielding gas to 100% argon — the CO_2 content in 75/25 Ar/CO_2 prevents spray transfer at any amperage level; spray transfer on carbon steel requires argononly shielding or blends with less than 3% active gas content

C. Increase the wire feed speed above the spray transition current threshold for this gaswirediameter combination — spray transfer requires the amperage to exceed a critical minimum value determined by the wire diameter, chemistry, and shielding gas; below this transition current, globular transfer occurs; above it, spray transfer is established through the electromagnetic pinch force mechanism

D. Increase arc voltage above 35 V — spray transfer initiates when voltage rises above the globulartransfer voltage range, and the transition from globular to spray is controlled entirely by voltage at any wire feed speed above the minimum required for shortcircuit transfer

93. A GMAW operator using 1.2 mm ER70S6 wire at 7 m/min WFS producing 190 A is asked to increase the deposition rate without changing WFS or gas flow by increasing CTWD from 18 mm to 28 mm. What is the primary effect of this CTWD increase?

A. Increasing CTWD increases resistive (I^2R) preheating of the wire stub — the longer stub heats the wire before it reaches the arc, reducing the arc energy needed to complete melting; on a CV machine, the set voltage is maintained but less current is required from the power source since the wire arrives partially preheated, slightly decreasing amperage while the increased wire melting efficiency provides a modest deposition rate increase per unit arc energy

B. Increasing CTWD increases the arc length proportionally — a 10 mm increase in CTWD produces a corresponding 10 mm arc length increase, raising arc voltage by 10% through Ohm's law and proportionally increasing the welding current from 190 A to approximately 209 A

C. Increasing CTWD has no effect on deposition rate or any process parameters — CTWD is an ergonomic variable affecting viewing angle only, with no electrical or metallurgical significance in the GMAW process

D. Increasing CTWD reduces the deposition rate by 30% — the extended stickout requires additional arc energy to melt the longer wire length before it reaches the pool, consuming energy that would otherwise contribute to base metal fusion

94. A structural steel erector must complete fillet welds on a building frame during 25 km/h wind conditions. Available wire options are ER70S6 solid wire (GMAW), E71T1M gasshielded FCAW, and E71T8 selfshielded FCAW. Which wire can be used without additional windscreen protection?

A. ER70S6 solid wire — the argon content of the 75/25 shielding gas is heavier than air and provides adequate shielding at ground level regardless of wind speed up to 40 km/h, since the dense argon sinks below the wind velocity gradient to the weld pool surface

B. E71T1M gasshielded FCAW — the metallic flux core in T1M wire provides supplemental shielding to the external gas flow, doubling the effective coverage compared to solid wire and allowing unprotected outdoor welding in winds up to 30 km/h

C. E71T1M FCAWG in a windscreen enclosure — neither gasshielded process is suitable at 25 km/h without protection; both require wind enclosures since external shielding gases are disrupted above approximately 810 km/h

D. E71T8 selfshielded FCAW — the flux core generates nitrogenexcluding compounds internally during welding that shield the arc and solidifying pool without relying on an external gas stream; these internally generated shielding gases are not significantly affected by the wind and maintain weld quality in outdoor conditions where gasshielded processes require windscreens

95. A GMAW operator using spray transfer completes flat position (1F) structural fillet welds and is then asked to use the same parameters for horizontal position (2F) fillet welds. What quality concern arises, and what is the typical adjustment?

A. No adjustment is required — spray transfer parameters are directly transferable between 1F and 2F positions because the transfer mode and heat input are identical, and the horizontal position does not introduce any additional pool control challenges for spray transfer

B. Spray transfer creates a large, highly fluid weld pool that cannot be adequately controlled in the horizontal position — the high heat input and fluid pool in spray transfer cause sagging, overlap at the lower toe, and convexity at the upper toe in the 2F position; the process is typically converted to pulsed spray (pulsed GMAW) or a reduced heat input transfer mode to allow positional application with acceptable bead geometry

C. Horizontal fillet welding in spray transfer requires a 25% amperage increase above the 1F setting — the 2F position requires additional arc force to resist the gravitational sag that pulls the pool away from the upper plate toe, and the higher amperage provides the required arc force without changing the transfer mode

D. Spray transfer is prohibited for all 2F structural fillet welds under any conditions — all horizontal structural fillet welds must be made using shortcircuit or globular transfer as the only modes with adequate pool control at this position under the applicable structural welding codes

96. A production manager evaluates metalcored wire (MCAW) as an alternative to solid wire GMAW for flat and horizontal structural fillet welding. Which performance characteristic most directly differentiates metalcored wire?

A. Metalcored wire requires a higher arc voltage than solid wire at equivalent parameters — the higher core electrical resistance of the composite construction requires an additional 34 V compared to solid wire at the same wire feed speed, increasing heat input per unit length

B. Metalcored wire produces higher spatter levels than solid wire at equivalent transfer modes — the metallic powder core fragments unevenly at the arc tip compared to homogeneous solid wire, increasing spatter that requires additional postweld cleaning

C. Metalcored wire achieves higher deposition rates at equivalent amperage compared to solid wire — the composite tubeandpowder construction deposits additional metal from the core powder component simultaneously with the outer tube material, providing more deposited metal per unit of arc time than solid wire at the same nominal diameter and parameters

D. Metalcored wire requires a minimum of 15% CO_2 in the shielding gas — the metallic core chemistry is incompatible with argonrich shielding blends above 85% argon and produces cold lap defects at the weld toes when CO_2 content falls below the minimum threshold

97. A structural application requires welding in all positions including overhead (4G) and verticalup (3G). The available wire is classified E70T1C. Can this wire be used for all required positions?

A. E70T1C is limited to flat and horizontal positions — the T1 designation identifies a rutile flux system producing a large, fluid slag that cannot be controlled in overhead or vertical positions; allposition versions carry an additional "1" in the tensile strength designation (e.g., E71T1C), and E70T1C must not be used for the overhead and verticalup positions in this application

B. E70T1C is an allposition wire — the "C" suffix modifier confirms an adjusted flux chemistry that provides superior weld pool control in overhead and vertical positions regardless of the base T1 designation

C. Position capability of FCAW wire is not encoded in the AWS classification number — the applicable positions must be obtained from the wire manufacturer's data sheet, and the classification communicates only mechanical properties and flux system type

D. Any FCAW wire classified under AWS A5.20 can be used in all positions at reduced amperage settings — the position limitation in the base classification is a guidance value that can be overridden by WPS parameter testing, and the T1 limit to flat and horizontal applies only at the maximum rated amperage for the diameter

98. A GMAW operator experiences significant weld metal porosity after changing to a new cylinder of 75/25 Ar/CO_2 shielding gas. The cylinder label confirms the correct gas blend, the regulator reads 15 L/min, and the electrode extension is correct. What is the most probable cause?

A. The CO_2 has fractionated from the argon during transit — CO_2 and argon separate during shipping with CO_2 settling to the bottom; inverting the cylinder three times before connecting remixes the gases and eliminates the porosity on subsequent welds

B. The 15 L/min flow rate is inadequate for the new cylinder's gas blend — different production batches of the same gas blend require different minimum flow rates, and the new cylinder requires 20 L/min minimum to provide acceptable atmospheric protection for the arc

C. The new cylinder may contain air contamination introduced during improper filling or through a damaged cylinder valve seat — trace amounts of nitrogen and oxygen from the air contamination produce atmospheric nitrogen and hydrogen porosity in the deposit even at standard flow rates with otherwise correct parameters

D. The new cylinder may contain moisture — water vapor contamination in the shielding gas cylinder produces hydrogen porosity in the weld deposit; moisture contamination can originate from improperly purged cylinders, damaged valve seals, or noncompliant filling procedures, and the cylinder should be returned to the supplier for replacement

99. An FCAWG operator producing verticalup multipass fillet welds with E71T1M wire finds slag inclusions at the fusion boundaries between passes. Voltage and wire feed speed are within the WPS range. What technique modification most directly prevents interpass slag inclusions?

A. Switch to verticaldown travel direction for all fill passes — interpass slag inclusions in verticalup FCAW are exclusively caused by the upward travel direction, and converting all fill passes to verticaldown welding eliminates the slag trapping mechanism in multipass vertical fillet applications

B. Completely remove slag by chipping and wire brushing between every pass and inspect the surface for any remaining slag bridges before depositing the next pass — thorough interpass cleaning removes all slag that would otherwise be incorporated into the subsequent pass deposit, eliminating the source material for interpass slag inclusions

C. Increase the wire feed speed above the WPS maximum for fill passes only — higher deposition in the fill passes creates sufficient heat to melt any residual slag from previous passes into the current pool, where it floats to the surface rather than remaining as trapped inclusions

D. Use a backstep technique for all fill passes — depositing each segment in the reverse direction causes residual slag to move toward the leading pool edge where it is expelled ahead of the arc rather than being overtaken and trapped beneath the advancing pool

100. A GMAW operator experiences intermittent wire feed problems — smooth feeding for several minutes followed by brief arc extinction, wire stoppage, and then resumption. Drive rolls show no slippage and the liner is clean. What is the most probable cause?

A. Intermittent shielding gas pressure drops are causing the power source to suspend wire feed automatically — the arc voltage monitoring system detects the gas deficiency and commands the feeder to pause until gas pressure is restored to the minimum specification

B. The contact tip is undersized for the wire diameter — the smaller bore creates intermittent wire jams at the tip entry chamfer, producing the brief stopandresume pattern described whenever a wire coil contacts the restriction point in the tip bore

C. A kink or coil misalignment is occurring at the wire spool — as the spool rotates, a misaligned wire coil periodically catches on the spool flange, momentarily blocking feed and causing the brief arc extinction; when the wire releases, feed resumes; the spool backtension brake and wire alignment must be inspected and corrected

D. The workpiece is insufficiently grounded — intermittent contact between the work lead clamp and the workpiece surface creates momentary opencircuit conditions detected by the power source shortcircuit monitor, which interrupts wire feed at each opencircuit event

101. A GTAW welder completing passes on 6061T6 aluminum finds dark smudge marks embedded in the weld face at locations where arc stops and restarts occurred. What causes these marks, and what technique eliminates them?

A. The marks result from tungsten oxide deposited as the electrode tip oxidizes at each arc stop — briefly switching to DCEP arc before restarting AC at each location removes the oxide layer from the electrode tip; the DCEP postpurge restores a clean electrode before AC welding resumes

B. The dark zones are areas of incomplete cathodic cleaning — oxide that was not removed by the arc at restart locations produces the dark appearance; increasing the AC balance toward electrodepositive at restart locations provides stronger cathodic cleaning to eliminate the marks

C. The marks are normal AC GTAW artifacts at arc restart locations and require no corrective action — the temporary tungsten emission changes at arc reestablishment produce a cosmetic discoloration that does not affect the mechanical properties of the completed weld

D. The marks result from aluminum oxide being folded into the weld pool at arc stop locations — when the arc stops, the aluminum pool surface oxidizes rapidly in air; restarting the arc pushes this surface oxide into the deposit; the technique correction is to use a runoff tab for arc stops, slope down to a fully filled crater before extinguishing, and allow postflow shielding gas to protect the pool until it solidifies and cools below the oxidation threshold

102. A GTAW operator attempts welding 2 mm wall aluminum tubing using DCEP (electrode positive) with a 2.4 mm EWP electrode. After a few seconds the electrode develops a large shiny ball and the penetration is very shallow. Why is DCEP producing these results, and what is the purpose of using it?

A. Under DCEP, approximately 70% of arc energy concentrates at the electrode (anode), causing it to heat and form the characteristic ball while simultaneously providing intense cathodic cleaning of the aluminum surface oxide during the complete welding period — DCEP is used in specific thinsection and tubeend applications to achieve maximum cathodic cleaning action, and the balling electrode and shallow penetration are the expected and accepted characteristics of this technique

B. The balling electrode indicates the 2.4 mm electrode is undersized for the DCEP amperage being used — replacing the electrode with a 3.2 mm diameter eliminates the balling while maintaining the DCEP polarity required for aluminum welding

C. The EWP electrode is incompatible with DCEP — pure tungsten is classified exclusively for AC operation, and the balling forms on DC because EWP lacks the thermionic emission additive needed to prevent tip melting on any DC polarity

D. DCEP on aluminum concentrates arc energy at the base metal rather than the electrode, causing shallow penetration — under DCEP, the electron flow from the base metal to the electrode generates a surface cleaning action that is the same mechanism as AC electrodepositive halfcycles; the shallow penetration confirms that DCEP correctly directs energy away from the base metal for thinsection applications

103. A GTAW welder has been backpurging a 316L stainless steel spool for 20 minutes with argon at standard flow. The oxygen analyzer at the downstream vent reads 1,500 ppm. The WPS requires below 1,000 ppm before welding begins. What is the correct action?

A. Begin welding immediately — 1,500 ppm is within 50% of the specification, and industry consensus permits root pass welding when oxygen levels fall below 2,000 ppm since the torch postflow argon provides the remaining protection needed to meet 1,000 ppm at the actual weld root

B. Continue purging at the same flow rate until the analyzer confirms the oxygen level has dropped to 1,000 ppm or below before beginning any welding — the 20minute purge has not yet achieved the specification; additional purge time will continue displacing residual oxygen and the level will decline toward the acceptance threshold

C. Seal the downstream vent to forcepressurize the pipe interior — the increased internal pressure drives out residual oxygen through any remaining microleaks in the seal system, rapidly lowering the oxygen content below the 1,000 ppm specification for welding

D. Accept the reading and begin welding — the oxygen analyzer measures at the downstream vent where atmospheric oxygen enters first during any purge reversal; the actual oxygen level at the weld zone in the middle of the spool is lower than the downstream reading, and production welding may begin when the downstream reading falls below 2,000 ppm

104. A GTAW welder alternates between welding carbon steel and 304L stainless steel components using the same tungsten electrode and filler rod holder without cleaning between materials. What quality concern does this practice create for the stainless steel welds?

A. Carbon steel residue on the tungsten increases the thermionic emission of the electrode, causing the GTAW arc to spread too wide on the stainless steel and producing a bead that exceeds the specified maximum width in the WPS for the stainless application

B. Carbon steel contamination from the electrode introduces iron into the stainless pool, diluting the chromiumtoiron ratio below the 11% minimum in the fusion zone adjacent to the contaminated arc start location

C. Carbon steel residue on the tungsten, filler rod holder, and work surfaces can transfer iron and carbon contamination to the stainless steel weld zone — iron pickup reduces local chromium concentration while carbon introduction promotes sensitization; maintaining dedicated stainless tools, tungsten electrodes, and filler rods that are never used on or contacted by carbon steel is required to prevent this crosscontamination in corrosioncritical stainless applications

D. Crosscontamination with carbon steel has no practical effect on stainless steel GTAW weld quality because arc temperature of approximately 11,000°C vaporizes all contaminants before they can influence the weld pool chemistry — the concern about crosscontamination is a commercial myth promoted by equipment manufacturers

105. A GTAW welder completing an autogenous (no filler) root pass on 3 mm wall 304L stainless steel pipe produces full fusion across the joint but the root bead profile is concave — sunken relative to the pipe ID surface. What is the most likely cause and what corrective technique addresses it?

A. The concave profile results from excessive arc voltage — the longer arc length spreads heat too broadly and prevents metal from building up at the root; reducing arc length to approximately 1.5 mm eliminates the concavity by concentrating heat at the root centreline

B. Concave root beads on autogenous pipe joints are codeacceptable — autogenous GTAW always produces concave root profiles on pipe and the condition is approved for autogenous root passes in all applicable pressure piping codes without corrective action

C. The concave profile results from argon back purge flow rate being too low — inadequate purge flow allows oxygen to react with the underside of the root pass, and the oxide formation pulls the root surface inward; increasing the back purge flow to 8 L/min corrects the concavity pattern

D. The concave root bead results from excessive travel speed combined with insufficient amperage — the arc advances faster than the weld pool can fill the root preparation, leaving a sunken centreline; reducing travel speed or increasing amperage ensures adequate molten metal pools at the root to produce a flush or slightly convex bead profile

106. A GTAW welder using a standard collet body torch consistently experiences tungsten contamination during thinwall stainless steel tube welding. A colleague suggests installing a gas lens in the torch. How does the gas lens improve shielding performance?

A. A gas lens replaces the standard collet body with a porous mesh disc screen that produces a laminar, lowturbulence shielding gas stream around the electrode and arc zone — the laminar flow provides more uniform atmospheric exclusion over a wider area, allows the tungsten electrode to be extended further from the nozzle without losing shielding effectiveness, and reduces tungsten contamination by maintaining a clean, stable gas envelope around the arc during the entire weld cycle

B. A gas lens reduces the shielding gas delivery pressure by creating a larger gas volume above the arc — the lowerpressure flow reduces arc turbulence that deflects the electrode tip toward the pool during arc initiation and is the primary mechanism causing tungsten contamination in tube welding

C. A gas lens increases the gas flow rate by eliminating the collet body flow restriction — the higher flow rate continuously flushes any particulate contaminants from the torch body before they can deposit on the tungsten, preventing the electrode contamination that causes arc instability

D. A gas lens contains a copper mesh that acts as a static electricity filter — the mesh removes ionizing charge from the shielding gas stream that deflects the arc toward the torch body during closeclearance tube welding, which is the primary cause of tungsten contamination in these applications

107. A GTAW welder is preparing a root pass on Schedule 40, 4inch NPS carbon steel pipe (OD = 114.3 mm, wall = 6.02 mm). Which filler rod diameter selection guideline applies for this root pass application?

A. Select 3.2 mm filler rod — the filler rod diameter must always exceed the pipe wall thickness to provide sufficient metal volume per addition to fill the root gap with minimal dipping frequency; at 6 mm wall thickness, 3.2 mm is the minimum rod diameter that can fill the root in an acceptable number of additions

B. Select 3.2 mm filler rod — the filler rod diameter must match the tungsten electrode diameter used for the application; 6 mm wall thickness requires a 3.2 mm tungsten electrode, and the filler rod must be the same diameter as the tungsten to maintain consistent arc geometry

C. Select 2.4 mm filler rod — for pipe root passes, the filler rod should approximate the root gap dimension, allowing precise incremental additions; for 4inch Schedule 40 pipe, a 2.4 mm rod provides the controlled, incrementally deposited metal additions that give the welder precise management of root pass reinforcement and keyhole fill volume with each dip

D. Filler rod diameter has no practical effect on pipe root pass quality — arc energy and not rod diameter controls the root pass penetration and bead profile, so either 2.4 mm or 3.2 mm produces equivalent results and the selection is based entirely on available inventory

108. A GTAW welder producing multipass stainless steel welds without interpass cleaning produces a weld with small pock marks and embedded dark particles visible in the weld face when the joint is ground flush. What is the source of these inclusions and what cleaning procedure prevents them?

A. The pock marks are from tungsten inclusions from electrode tip erosion at each arc start — the tungsten particles erode at initiation and are deposited in the first millimetre of each new pass; increasing the HF arc start voltage frequency eliminates the initial tungsten erosion

B. The pock marks and dark particles result from interpass oxidation — even a thin gold or straw oxide layer that forms between passes must be completely removed by stainless steel wire brushing before depositing the next pass; any remaining surface oxide is melted into the new pool and trapped as dark inclusion particles when the pool solidifies

C. The inclusions are silicon islands from the ER316L filler deoxidizers — the SiO_2 deposits remaining on the face after each pass must be removed by grinding with an aluminum oxide wheel before depositing subsequent passes on the stainless surface

D. The dark particles are lead inclusions from the preweld cleaning solvent — lead in the solvent reacts with stainless alloy components at welding temperature to form lead intermetallic compounds that remain embedded in each pass face as the characteristic dark particles observed after grinding

109. A GTAW welder completing Grade 2 commercially pure titanium welds produces a weld face with heavy blue discoloration. What does the blue discoloration indicate and what corrective action is required?

A. Blue discoloration on titanium indicates tungsten oxide contamination — the electrode deposits tungsten oxide during the first arc initiation on cold titanium; running a 30second idle arc on a copper backing plate before beginning titanium production cleans the electrode and eliminates the blue discoloration on subsequent welds

B. Blue discoloration confirms the tungsten electrode diameter is too large for the welding amperage — the oversized electrode creates arc instability that allows air entrainment, producing the titanium oxide discoloration; reducing electrode diameter to the appropriate size for the amperage eliminates the contamination

C. Blue discoloration on titanium indicates insufficient argon purity — weldinggrade argon below 99.995% contains nitrogen and oxygen at concentrations that react with titanium; switching to certified ultrahighpurity argon immediately eliminates the blue discoloration pattern

D. Blue discoloration indicates the shielding coverage area is insufficient to protect the hot titanium surface — titanium reacts aggressively with oxygen and nitrogen above approximately 400°C; the blue color confirms hot metal above this temperature is being exposed to atmosphere; corrective action includes extending the trailing shield length, increasing postflow time, or adding a secondary shielding shoe to maintain inert coverage until the weld metal cools below the reaction threshold

110. A GTAW operator switches from standard DC to pulsed DC GTAW for 3 mm wall austenitic stainless steel pipe. The WPS specifies peak current 140 A, background current 40 A, pulse frequency 2 Hz, 50% duty cycle. What specific advantage does this pulsed mode provide?

A. The 140 A peak current delivers fusion energy during the peak phase while the 40 A background phase allows the pool to partially cool and partially solidify between pulses — this controlled heat delivery cycle provides complete penetration from the peak current while the background phase reduces average heat input, limiting distortion and HAZ width compared to continuous 140 A welding on the thinwall pipe

B. Pulsed GTAW eliminates the requirement for back purging on austenitic stainless steel — the intermittent arc at 2 Hz prevents heat accumulation that causes rootface oxidation, and the weld root can be left unprotected when pulsed GTAW parameters are correctly applied

C. Pulsed GTAW reduces diffusible hydrogen below that of standard DC GTAW — the rapid current cycling at 2 Hz prevents hydrogen from the shielding gas from being incorporated into the weld pool during the background current phase of each cycle

D. Pulsed GTAW at 2 Hz is designed exclusively for orbital welding machines — the pulsed current at this frequency requires the HF arc reestablishment capability that is available only on automated orbital systems, and is not compatible with manual GTAW torches

111. A GTAW welder is joining 5083H321 aluminum plate that will be anodized after welding. Which filler wire selection addresses both the mechanical property requirements and the postweld anodizing compatibility requirement?

A. ER4043 (AlSi) — this is the most commonly available aluminum GTAW filler and produces weld deposits with excellent corrosion resistance and bright uniform appearance after anodizing that cosmetically matches the 5083 base metal in all aluminum alloy applications

B. ER1100 (pure aluminum) — pure aluminum filler is always selected for anodizing applications because the absence of all alloying elements produces the same anodizing response as any base metal alloy, providing the best possible cosmetic match regardless of base metal composition

C. ER5356 (AlMg) — for 5083 aluminum designated for anodizing, ER5356 is the preferred filler; the magnesium content of ER5356 produces an anodized weld deposit that closely matches the appearance of the anodized 5083 base metal, while ER4043 (high silicon) produces a distinctly darker, cosmetically unacceptable deposit when anodized due to the silicon's interaction with the anodizing bath chemistry

D. ER5554 (AlMgMn) — ER5554 is specifically designed for 5083 aluminum and contains the magnesiummanganese combination that exactly matches the 5083 composition, providing the closest possible anodized color match and the highest joint strength among all available filler options for 5083 base metal

112. A GTAW welder using AC for aluminum at 200 A with 3.2 mm EWP and pure argon shielding achieves good fusion but cannot maintain a short arc — it consistently extends to 810 mm despite effort to work closer. What is causing the unusually long arc distance?

A. The 3.2 mm electrode diameter is too large for 200 A on AC aluminum — the oversized electrode creates high arc column resistance that forces the arc to extend to maintain the correct electrical discharge characteristics; switching to a 2.4 mm electrode at 200 A corrects the arc length behavior

B. The EWP electrode has formed a large ball at the tip — at 200 A on AC, a 3.2 mm EWP electrode can develop a ball 56 mm in diameter; the larger ball diameter effectively increases the electrodetowork gap by the ball radius above the theoretical flattip position, creating the apparent 810 mm arc length even when the ball surface is reasonably close to the work; switching to 4.0 mm EWP supports the larger ball within a normal operating gap

C. The long arc results from nitrogen contamination in the argon shielding — trace nitrogen creates a longer ionized arc column than pure argon at the same arc voltage; replacing the cylinder with certified highpurity argon restores the normal 23 mm arc operating range

D. The long arc is caused by excessive shielding gas flow rate — high argon flow creates convective turbulence around the arc column that pushes the ionized gas away from the electrode; reducing the flow to 6 L/min eliminates the turbulencedriven arc extension

113. A GTAW welder backpurging a 6inch (168.3 mm ID) stainless steel pipe spool 3 metres long uses a 30 L/min argon flow rate. After 10 minutes the downstream oxygen sensor reads below 1,000 ppm. The root pass shows inconsistent color from silver to blue along the weld length. What is the most probable cause?

A. The inconsistent color results from variable travel speed — faster travel at some locations produced insufficient pool temperature for oxide formation while slower sections accumulated heat that caused the straw and blue discoloration at those specific clock positions

B. The inconsistent color indicates incomplete oxygen displacement — argon being denser than air displaced the bottom half of the pipe first, and the upper weld zone at 12 o'clock still had residual oxygen despite the sensor reading; the welder should have continued purging for 15 volume changes rather than relying on the sensor reading alone

C. The 30 L/min flow rate was too low to achieve consistent displacement throughout the 3metre spool — the total pipe volume required more than 10 minutes at 30 L/min to achieve 15 volume changes needed for reliable sub500ppm oxygen content throughout the full length

D. The 30 L/min flow rate was too high — the excessive flow created turbulence inside the pipe that entrained ambient air back into the pipe from the downstream outlet through negative pressure zones created by the highvelocity argon stream; reducing the flow to 68 L/min produces laminar, stratified displacement that achieves and maintains consistent below1,000ppm oxygen content throughout the spool without turbulencedriven air reentrainment

114. During SAW production, an operator recovers spent flux from the weld zone and returns it to the flux hopper without processing. After several recycling cycles, the welds show elevated porosity and fail Charpy impact testing. What is the primary quality concern with unprocessed flux recycling?

A. Recovered flux contains fine particles from flux fragmentation, slag chips, and moisture absorbed in the weld zone — fines and moisture introduce gas generation and chemistry changes in the recycled portion that cause porosity and alter the deposited weld metal composition toward lower toughness values; recovered flux must be screened to remove fines and slag, dried per the manufacturer's specification, and blended with fresh flux before returning to the hopper

B. Recovered flux always contains iron and manganese contamination that transfers from the melted weld pool into the flux during each arc cycle — the accumulation raises the deposit manganese above the WPS maximum, which is the direct mechanism causing the impact test failures after multiple recycling cycles

C. Recycled flux cannot be used under any circumstances — all flux that has passed through the arc zone must be discarded since the arc permanently alters the flux chemistry in ways that cannot be corrected by any processing step

D. Porosity from recycled flux results exclusively from static electricity buildup on the recovered particles during pneumatic conveying — the charged particles repel each other and create nonuniform coverage that allows atmospheric contamination at the arc zone; antistatic treatment of the conveying system corrects the porosity without requiring any flux processing

115. A SAW welding engineer specifies a maximum depthtowidth (D/W) ratio of 0.75 for production weld bead crosssections. During production, the measured D/W ratio is 1.05. What quality concern does this elevated ratio create, and what parameter adjustment reduces it?

A. The elevated D/W ratio indicates the bead is wider than the groove preparation — the excess lateral extent creates a reduced effective throat and the weld must be trimmed to the specified dimensions before pressure testing

B. The elevated D/W ratio reduces corrosion resistance by increasing the weld metal surface area exposed to the process medium — the correction is to reduce the groove angle to bring the bead geometry within the specified ratio

C. A D/W ratio above 1.0 means the bead is deeper than it is wide — this geometry concentrates solidification contraction stresses and lasttosolidify segregates along the bead centreline, creating susceptibility to centreline solidification cracking; reducing amperage, increasing travel speed, or increasing voltage to widen the bead are the appropriate parameter adjustments that reduce the D/W ratio toward the specified maximum

D. The elevated D/W ratio results from insufficient flux coverage depth — increasing flux burden from 25 mm to 40 mm above the arc produces a more rounded bead crosssection that physically reduces the D/W ratio by confining the molten pool within the flux burden

116. A SAW procedure specifies a neutral flux for a chromemoly pressure vessel seam. The supplier offers an active flux of the same base classification number as a temporary substitute. What specific chemistry concern prevents this substitution without procedure requalification?

A. Active flux contains higher concentrations of organic binders than neutral flux, and these binders decompose at the weld zone to generate hydrogen that exceeds the H4 diffusible hydrogen limit specified for chromemoly alloy steel in the applicable pressure vessel code

B. Active flux adds manganese and silicon to the deposited weld metal through arc reactions, while neutral flux maintains a deposit composition close to the wire chemistry — substituting active flux for neutral flux changes the weld metal chemistry and may push the deposit composition outside the Anumber range qualified by the WPS, constituting an essential variable change that requires procedure requalification

C. Active flux has a lower melting temperature than neutral flux — the lowermelting active flux solidifies before the weld metal on chromemoly steels, constraining the pool and creating internal restraint that prevents proper bead formation during the PWHT temperature cycle

D. Active and neutral flux designations refer only to the particle size distribution and have no effect on deposit chemistry — both flux types produce the same deposited composition when paired with the same wire, and the substitution is fully acceptable without any procedure changes

117. A SAW procedure uses singlewire fully automatic welding to complete a 300 mm longitudinal seam on a 75 mm wall pressure vessel requiring approximately 30 kg of weld metal deposit. A proposal is made to switch to tandem twowire SAW for the remaining identical vessels in the production run. What most accurately describes the production advantage of the tandem system?

A. Tandem SAW allows pressure vessel welding in vertical and overhead positions that singlewire SAW cannot achieve — the opposing arc forces from the two electrodes balance each other and enable operation outside the flat position

B. Tandem SAW requires half the operator supervision compared to singlewire — the dual arc control system automatically monitors and balances both arcs, allowing a single operator to monitor two tandem machines running simultaneously

C. Tandem SAW consumes half the flux per kilogram of weld metal deposited compared to singlewire SAW — the dual arcs create an enlarged flux cavity that is more thermally efficient per unit of weld metal, reducing consumable cost below singlewire levels

D. Tandem SAW achieves substantially higher deposition rates than singlewire SAW — depositing from two electrodes simultaneously (lead DCEP plus trail AC) produces deposition rates often double or more that of singlewire operation, significantly reducing the number of passes and total arc time needed to complete the 30 kg groove on each vessel shell

118. A purchasing agent must order SAW flux to meet the specification "F7A4EM12K aswelded condition." Two available products are Brand A (classified F7A4EM12K) and Brand B (classified F7A2EM12K). Which products meet the specification?

A. Only Brand A (F7A4) meets the specification — F7A4 confirms the fluxwire deposit was tested in the aswelded condition at −40°F (the "4" designating the Charpy test temperature at 4 × −10°F = −40°F); Brand B (F7A2) was tested at −20°F (2 × −10°F) and may not provide the −40°F impact performance the specification requires

B. Both brands meet the specification — F7A2 and F7A4 are equivalent for production purposes because the Charpy test temperature designation in SAW flux classification represents a minimum classification floor, and both brands qualify above the F7A0 minimum required level

C. Only Brand B (F7A2) meets the specification — the lower Charpy test temperature number in the F7A2 designation means this flux was tested under more conservative conditions and provides a greater safety margin than the highernumber F7A4, which was tested under less stringent conditions

D. Neither brand meets the specification — both flux products must carry the exact same wire designation (EM12K) in an identical fluxwire classification number to be interchangeable; different flux brands with the same wire classification must be independently retested as F7A4EM12K to be substituted in the specification

119. A SAW operator begins production on 8 mm structural plate fillet welds using parameters optimized for the previous 25 mm plate project. What quality problem results and what parameter adjustment is required?

A. The 25 mm plate parameters produce incomplete fusion on 8 mm plate because the high travel speed optimized for thick plate moves the arc too fast for the low thermal mass of thin plate to reach the required fusion temperature — reducing travel speed is the only parameter adjustment needed

B. No quality problem will result — SAW fillet weld parameters are governed by the specified weld size, not the base plate thickness; the same combination that produces an acceptable fillet on 25 mm plate will produce the equivalent fillet on 8 mm plate at the same leg size specification

C. The parameters optimized for 25 mm plate deliver excessive heat input to the 8 mm plate, causing burnthrough, meltthrough, or severe thermal distortion — the parameters must be significantly reduced through lower amperage, higher travel speed, and/or reduced voltage to provide heat input appropriate for the thin plate crosssection

D. The parameters will cause slag inclusions only — the flux depth required for 25 mm plate creates excess slag burden that the smaller 8 mm weld pool cannot float effectively; reducing the flux depth while maintaining all other parameters is the only change required for the thin plate fillet application

120. When completing a circumferential SAW seam on a pressure vessel shell course, the final weld revolution overlaps the beginning of the weld by approximately 25 mm. What must be addressed at this overlap region before final acceptance?

A. The overlap region creates double reinforcement that must be ground flush — the combined weld bead height at the overlap zone exceeds the maximum cap reinforcement specification and must be mechanically removed to the singlebead level before the seam is submitted for final NDE

B. The weld start location within the overlap region requires specific inspection — the initial arc strike at the start of circumferential SAW may contain porosity, partial slag inclusions, or a crater from the original starting conditions; this start zone within the overlap area must be excavated and inspected by NDE to confirm sound metal throughout before any overlap material is deposited over it

C. The entire overlap region must be radiographed with a minimum 300 mm film length centered over it — all circumferential SAW seam overlaps require mandatory RT coverage regardless of the examination plan applied to the remainder of the seam under all applicable pressure vessel codes

D. The overlap zone requires PWHT at twice the normal temperature — the double thermal cycle in the overlap creates a harderthannormal HAZ that cannot be adequately tempered at the standard PWHT temperature; a dedicated elevatedtemperature PWHT is required for the overlap zone before the seam is accepted

121. A welding engineer compares singlewire SAW and tandem twowire SAW for completing 300 mm longitudinal seams on 75 mm wall pressure vessels requiring approximately 30 kg of weld metal per seam. What most accurately describes the tandem system's production advantage?

A. Tandem SAW enables welding in vertical and overhead positions that singlewire SAW cannot achieve — the dual electrode configuration counterbalances gravitational effects and allows outofposition operation on heavy vessel shells

B. Tandem SAW reduces operator monitoring requirements by half — dualarc control automation allows a single technician to oversee two tandem systems simultaneously, halving the direct labor cost compared to two singlewire systems

C. Tandem SAW consumes half the flux per kilogram of weld metal deposited — the combined flux cavity of the two arcs uses flux more efficiently than two independent singlewire arcs, lowering consumable cost on the thickgroove fill

D. Tandem SAW achieves substantially higher deposition rates than singlewire SAW — depositing from two electrodes simultaneously produces deposition rates significantly exceeding singlewire capability, sharply reducing the number of passes, arc time, interpass temperature management cycles, and total production cost needed to fill 30 kg of groove volume on each pressure vessel shell seam

122. A SAW procedure is qualified for an impacttested application at −40°C. During production, the heat input is measured at 5.8 kJ/mm compared to the qualified maximum of 4.5 kJ/mm. What metallurgical effect in the HAZ most directly explains why maintaining the maximum heat input limit is essential for reproducing the PQR Charpy results?

A. Excessive heat input produces a coarser prior austenite grain in the coarsegrained HAZ — the increased heat input extends the time the HAZ spends above the graincoarsening temperature, growing larger prior austenite grains that reduce impact toughness because larger grains have less total grain boundary area available for absorbing fracture energy; the Charpy toughness achieved in the PQR at the qualified heat input cannot be reproduced at the higher heat input

B. Excessive heat input permanently elevates the carbon content of the HAZ through diffusion from the weld metal — the additional carbon at 5.8 kJ/mm transforms the HAZ chemistry from lowcarbon to mediumcarbon steel, which was not tested during the PQR qualification sequence

C. Excessive heat input creates permanent magnetization in the HAZ that causes arc blow in subsequent passes, reducing weld quality throughout all following SAW passes on the same vessel course

D. Excessive heat input converts the normally ferritic HAZ microstructure to a permanently austenitic structure — the phase transformation at elevated heat input produces a zone with inadequate toughness at the required −40°C impact test temperature that was not evaluated during PQR testing

123. A SAW operator is welding a pressure vessel longitudinal seam that was tackwelded with SMAW E7018 electrodes. Porosity clusters appear on the surface of the completed SAW bead directly above the locations of every tack weld. What is causing this localized porosity pattern?

A. The tack welds have residual magnetism from the DC welding power source — this magnetism creates arc blow as the SAW arc passes over each tack, deflecting the arc away from the centerline and allowing atmospheric contamination that produces the porosity at each tack location

B. The tack welds contain diffusible hydrogen from E7018 electrodes that were exposed to atmospheric moisture before use — when the SAW arc remelts each tack weld, the stored diffusible hydrogen is rapidly liberated from the remelted tack metal, exits through the molten SAW pool surface, and produces the porosity cluster directly above each tack weld location

C. The tack welds have slag on their surfaces that was not removed before SAW — the SAW arc remelts each tack and the E7018 slag mixes with the SAW flux, creating a localized chemistry incompatibility that traps gas at each tack location

D. The tack welds protrude above the adjacent plate surface — the convex tack profile causes the SAW flux to flow away from the elevated location, reducing flux coverage and allowing atmospheric contamination of the pool surface that produces porosity directly over each tack weld

124. Under ASME Section IX, a SAW procedure is being qualified for an application requiring Charpy Vnotch impact testing at −40°C. From which locations in the PQR test coupon must Charpy impact specimens be extracted?

A. Specimens from the weld centerline only — the centerline always represents the minimum toughness location in SAW weld metal and qualifying the worst case ensures all other weld zones will meet the minimum automatically

B. Specimens from the heataffected zone only — impact testing of the base metal HAZ is the sole requirement for SAW procedure qualification since weld metal toughness is guaranteed by the fluxwire classification and the base metal itself is covered by the material specification

C. Specimens must be extracted from both the weld metal and the heataffected zone — weld metal specimens confirm the SAW deposit independently meets the minimum impact energy, and HAZ specimens confirm the base metal was not embrittled by the SAW thermal cycle; both zones must independently satisfy the minimum requirements when impact testing is specified in the procedure qualification

D. Weld centerline specimens only for singlepass SAW; root pass area specimens only for multipass — the root pass HAZ experiences the most thermal cycles in multipass SAW and represents the minimumtoughness location that governs the qualification outcome for all multipass procedures

125. During SAW of a thicksection pressure vessel, fine transverse cracks are found in completed weld passes running perpendicular to the weld axis, initiating at the bead centreline. The procedure uses highMn, highSi wire with an active flux. Preheat and interpass temperatures were within specification. What is the most probable cause?

A. Lack of fusion between passes — the transverse cracks at the centreline on highcarbon base metal result from fusion boundary low ductility rather than solidification, and the cracks propagate from the fusion line toward the face under residual stress from subsequent passes

B. Hydrogeninduced cold cracking — the active flux with highMn, highSi wire introduces elevated diffusible hydrogen that concentrates at the weld bead centreline; delayed cold cracking initiates there when hydrogen accumulates to threshold concentration under the residual stress of overlying passes

C. Slag inclusion breakdown — active flux at elevated heat input generates unstable decomposition products that infiltrate the solidifying centreline, and the trapped incompatible slag compounds fracture transversely under the solidification contraction stress

D. Solidification hot cracking from a combination of high depthtowidth ratio bead geometry and excessive Mn and Si pickup from the active flux — the additional alloy element contribution from the active flux raises the deposit Mn and Si above levels that concentrate lowmelting segregates at the solidification front; when the D/W ratio creates a deep, narrow pool, solidification contraction stresses pull the stillliquid centreline apart, producing the transverse centreline hot cracks observed

Practice Exam 6: Answer Key and Explanations

Q1 — Correct Answer: B

Acetylene (UN1001) must be transported in the upright position with valve protection caps installed and cylinders secured against tipping and movement. Vehicles transporting quantities exceeding the smallquantity exemption threshold under TDGR Schedule 1 must display the required dangerous goods placard. A is wrong because horizontal transport of acetylene cylinders is specifically prohibited — acetylene is dissolved in acetone in the cylinder and must remain upright. C is wrong because the smallquantity exemption applies only below specific thresholds; above those, placarding is mandatory regardless of vehicle type. D is wrong because TDGR does not impose a 3G dynamic load factor requirement on cylinder retaining brackets for road transport.

Q2 — Correct Answer: D

Canadian OHS legislation in all provinces provides workers the right to refuse work they have reasonable cause to believe poses an undue hazard to their health. The procedure is: notify the supervisor of the refusal and the reason → allow the employer to investigate → if unresolved, refer to the JHSC or OHS officer → if still unresolved, contact the OHS authority. The worker cannot be disciplined for a goodfaith refusal throughout this process. A is wrong because walking off the job without following the refusal procedure violates OHS legislation — the worker must follow the defined steps. B is wrong because purchasing your own PPE as a substitute for a broken engineering control is not the legal mechanism for resolving this type of hazard. C is wrong because a scheduled repair date does not eliminate the right to refuse a currently hazardous condition.

Q3 — Correct Answer: A

In an electrical rescue, the rescuer's own safety is the absolute first priority. If the victim is still in contact with the energized conductor, touching the victim directly transfers the current to the rescuer and creates a second victim. The power source must be deenergized at the nearest disconnect or contact broken with a nonconductive object before any physical assistance is provided. B is wrong because calling emergency services, while critical, must not be done while the victim remains in contact with the live conductor — that sequence endangers the rescuer. C is wrong because performing an ABCs check from a distance does not address the ongoing electrocution. D is wrong because standard leather welding gloves are not classified as electrical PPE and provide no reliable protection against line voltage shock.

Q4 — Correct Answer: C

Sustained forward head posture (30° flexion) combined with trunk flexion throughout a full shift places the greatest loading on the cervical spine and upper thoracic spine. The most effective administrative control is repositioning the work to a height and angle that allows a neutral spine posture, supplemented by scheduled microbreak rotation to interrupt the sustained loading. A is wrong because carpal tunnel syndrome results from repetitive wrist flexion, not from the described trunk and neck posture. B is wrong because back support belts address lumbar loading and are not the primary control for cervical/upper thoracic strain. D is wrong because the described posture primarily loads the cervical and upper thoracic spine, not the knee and ankle complex.

Q5 — Correct Answer: B

NFPA 51B and equivalent Canadian fire and safety codes for hot work require a fire watch to remain at the work site for a minimum of 30 minutes after all hot work has ceased. This accounts for smoldering materials that were heated during the work but did not immediately ignite — combustion can develop well after the hot tool is removed from the area. A is wrong because 5 minutes is far too short and is not the codespecified minimum. C is wrong because 10 minutes is not the standard minimum under Canadian hot work codes. D is wrong because 30 minutes, not 60, is the standard minimum; the 30minute requirement applies regardless of whether cutting or welding was performed.

Q6 — Correct Answer: A

Using the NIOSH derated method: required attenuation = 95 − 85 = 10 dB(A). The formula is: (NRR − 7) ÷ 2 ≥ 10, which gives NRR − 7 ≥ 20, therefore NRR ≥ 27. B is wrong because applying the NRR directly without the derating factor overestimates the realworld protection the device provides. C is wrong because the NIOSH method requires subtracting 7 before dividing by 2 — omitting the 7 dB correction underestimates the required NRR. D is wrong because a 25% derating with a 2 dB safety margin is not the NIOSH formula — the published NIOSH method applies a 50% reduction after the 7 dB spectral correction.

Q7 — Correct Answer: D

Welding and grinding dust containing hexavalent chromium (Cr(VI)), manganese, and nickel can meet the federal and provincial regulatory criteria for hazardous waste classification under CEPA and associated provincial environmental legislation. The shop must characterize the material to determine whether it meets the hazardous threshold before it can be disposed of, and if classified as hazardous, it requires licensed manifesting, transport, and disposal. A is wrong because heavymetalcontaining grinding dust is not classified as inert solid waste. B is wrong because ignitability alone is not the only characterization criterion for welding/grinding dust — heavy metal content triggers separate characterization requirements. C is wrong because no automatic smallquantity exemption exists for hazardous waste characterization based on monthly generation volume.

Q8 — Correct Answer: C

The second worker's presentation — absent sweating, confusion (altered mental status), and a measured skin temperature of 41°C — is the clinical picture of heat stroke. Heat stroke is defined by a core temperature above 40°C combined with central nervous system dysfunction (confusion, loss of consciousness) and typically absent sweating in the classic form. It is a lifethreatening emergency requiring immediate aggressive cooling and emergency medical response. A is wrong because heat exhaustion typically presents with heavy sweating and weakness, not absent sweating and confusion. B is wrong because heat syncope is a fainting episode from blood pressure drop during transition from heat to cooler environments, not the combination of absent sweating, confusion, and elevated temperature. D is wrong because hyponatremia is a distinct condition with different symptoms not described in this scenario.

Q9 — Correct Answer: B

Total load = (3 welders × 95 kg) + 280 kg equipment + 120 kg power source = 285 + 280 + 120 = 685 kg. The posted scaffold capacity is 1,100 kg. Since 685 kg is less than 1,100 kg, the configuration is compliant with 415 kg of remaining capacity. A is wrong because the power source cannot be excluded from the platform load calculation — all mass on the platform must be included. C is wrong because no CSA scaffold standard automatically halves the rated capacity when powered electrical equipment is placed on the platform. D is wrong because there is no 0.7 weight factor applied to welding equipment in scaffold load calculations.

Q10 — Correct Answer: A

The WHMIS 2015 exclamation mark pictogram covers a range of moderate health hazards including skin and eye irritation, skin sensitization, acute toxicity at lower concern levels (oral/dermal Category 4, inhalation Category 4), specific target organ toxicity from single exposure, and respiratory tract irritation. The employer's obligation is to ensure the SDS is accessible and workers have been trained before using the product. B is wrong because the exclamation mark is not the explosive substance pictogram — that is the exploding bomb. C is wrong because the exclamation mark is not the environmental hazard pictogram — that uses the dead fish and tree symbol. D is wrong because compressed gases have their own distinct gas cylinder pictogram.

Q11 — Correct Answer: D

The minimum clear fall distance for a PFAS must account for every component that adds to the total arrest distance: lanyard length (1.8 m) + deceleration distance (0.3 m) + Dring height above the worker's feet (1.4 m) + harness elongation under arrest load (0.3 m) = 3.8 m minimum between the anchor point and any surface below. A is wrong because it omits the Dring height and harness elongation, both of which contribute to the total distance the worker travels below the anchor point during arrest. B is wrong because it omits the harness elongation contribution. C is wrong because no mandatory additional 1.0 m safety factor appears in the basic fall clearance formula.

Q12 — Correct Answer: C

Pure argon is a colorless, odorless asphyxiant with no warning properties. It is denser than air and accumulates in low, enclosed spaces. An hour of GTAW using argon shielding in a small enclosed tank displaces enough oxygen to produce the reported dizziness and lightheadedness. The coworker's critical error was entering the oxygendeficient space without first testing the atmosphere with a directreading instrument and without alerting the standby person — this placed both workers at simultaneous incapacitation risk. A is wrong because the scenario describes shielding gas asphyxiation, not heat stroke. B is wrong because NO_x toxicity is possible from arc welding but argon accumulation is the primary and more likely explanation in a GTAWonly scenario. D is wrong because ozone from GTAW dissipates rapidly, and the coworker entering without testing was the critical error regardless of the cause.

Q13 — Correct Answer: A

Under CSA W47.1, certified welding companies must maintain the three core documentation categories throughout their active certification period and make them available for CWB audit on demand: (1) welding procedure specifications (WPS), (2) procedure qualification records (PQR) supporting each WPS, and (3) welder and welding operator qualification records. Together, these documents demonstrate that both the procedures and the personnel executing them are qualified under the certification requirements. B is wrong because the WPS and PQR do not transfer to the vessel owner — they must be retained by the certified company. C is wrong because the CWB national welder database supplements but does not replace the company's obligation to maintain its own records. D is wrong because consumable purchase records alone are insufficient to satisfy W47.1 certification documentation requirements.

Q14 — Correct Answer: B

The lens shade selection guides for SMAW specify a minimum shade 12 for electrode diameters above 4 mm or welding amperages above 200 A. A 6 mm E7018 electrode at 250 A exceeds both thresholds, making shade 12 the appropriate selection — providing adequate UV and infrared filtration while maintaining sufficient arc pool visibility. A is wrong because shade 10 is appropriate for smaller electrodes (≤4 mm) or lower amperages, not for 6 mm electrodes at 250 A. C is wrong because shade 14 is not required for E7018 — the iron powder coating does not generate uniquely elevated radiation levels that mandate the maximum shade. D is wrong because shade 8 is far too light for this application and would cause serious UV radiation damage to the eyes.

Q15 — Correct Answer: D

CNSC regulations require that any worker who could receive a measurable radiation dose from ionizing radiation operations be evaluated for inclusion in the dose monitoring program. This includes potentially workers in adjacent areas if radiation dose rate surveys indicate doses approaching regulatory limits during a shift — it is not limited to the radiographers who directly handle the source. A is wrong because adjacentarea workers may receive measurable doses depending on shielding and distance. B is wrong because the monitoring obligation is not limited to those who physically entered the controlled area. C is wrong because Category II source use under CNSC licensing does not provide blanket exemption from individual dose monitoring for all nonradiation workers in the facility.

Q16 — Correct Answer: A

The 5G position requires the welder to continuously transition through the overhead (6 o'clock), vertical, and flat (12 o'clock) welding zones without rotating the pipe. The overhead and lowervertical segments demand sustained awkward arm elevation and neck extension that are entirely absent in 1G (flat/rotated pipe) work. This creates elevated cumulative exposure for the shoulder complex and cervical spine over extended production shifts. B is wrong because the cardiovascular demand of walking around the pipe is minor compared to the biomechanical loading from the overhead posture. C is wrong because shade adjustment is minimal and is not recognized as a primary ergonomic concern in 5G welding. D is wrong because the ergonomic risks between 5G and 1G are fundamentally different and welldocumented.

Q17 — Correct Answer: C

A flashpoint of 23°C is below the ambient shop temperature of 28°C. This means the solvent surface is continuously generating sufficient vapor to form an ignitable mixture with air at the work location — no heating of the solvent is needed to create a fire hazard. The flame pictogram is the correct WHMIS 2015 designation for flammable liquids in this hazard class. A is wrong because the compressed gas cylinder pictogram covers pressurized gas hazards, not flammable liquid vapor pressure. B is wrong because a flashpoint below ambient temperature does not automatically classify a substance as an acute toxic substance under WHMIS 2015. D is wrong because flammable liquids are a separate hazard class from explosive substances under WHMIS 2015.

Q18 — Correct Answer: B

Inside a small stainless steel vessel with a single 600 mm manway entry, welding fume including Cr(VI) can rapidly accumulate to concentrations that exceed the capacity limits of airpurifying respirator cartridge systems. The confined geometry prevents adequate dilution ventilation, making atmospheresupplying respiratory protection (SAR or SCBA) the only reliable protection for this combination of confined space and Cr(VI) fume generation. A is wrong because P100 filtration efficiency does not protect against cartridge capacity limitations — in high concentration environments the cartridge saturates regardless of its filtration efficiency rating. C is wrong because respiratory protection is essential for fume inhalation in this scenario — skin contact dermatitis is a separate and secondary concern. D is wrong because N95 is rated for oilfree particulate only and is not appropriate for Pclass filtration needs, let alone the confined space application that requires atmospheresupplying protection.

Q19 — Correct Answer: D

Canadian OHS legislation across all jurisdictions requires JHSC members performing workplace inspections to receive training that covers the applicable OHS legislation, hazard recognition and assessment methods, workplace inspection procedures, and incident investigation principles. The specific training duration and content are established by the applicable provincial or territorial legislation, and this training must precede formal inspection duties. A is wrong because a 2hour facility orientation is not adequate training for the JHSC inspection role under any provincial OHS legislation. B is wrong because OHS regulations require formal training, not just work experience. C is wrong because first aid certification is a separate requirement that does not substitute for JHSC inspection training.

Q20 — Correct Answer: C

SCBA management requires a twotier inspection approach: (1) a preuse inspection by the welder before every confined space entry, confirming no visible damage, adequate cylinder pressure, and a positivepressure facepiece seal; and (2) periodic inspection by a trained, competent person per the manufacturer's schedule to verify regulator function, cylinder hydrostatic test currency, and all safety features. Both levels are required by applicable confined space regulations and breathing apparatus standards. A is wrong because a visual check alone by the user is insufficient — periodic competentperson inspection is mandatory. B is wrong because the annual maintenance interval alone does not relieve the obligation for both the preuse check and the periodic inspection. D is wrong because no regulatory requirement mandates factory recertification after 60 days of storage — normal preuse and periodic inspection procedures apply.

Q21 — Correct Answer: A

In AWS A2.4 welding symbol conventions, "CJP" written above the reference line designates a complete joint penetration requirement. A number to the left of the groove weld symbol indicates the specified effective throat dimension. A filled flag at the reference line arrow junction designates field welding — work to be performed at the construction site rather than in the shop. Combined: a CJP groove weld with a 6 mm minimum effective throat, to be made in the field. B is wrong because the flag designates field welding, not mandatory NDE. C is wrong because groove angle is not communicated by a number to the left of the symbol in this convention. D is wrong because "CJP" is not an abbreviation for "Calculated Joint Procedure" — it means Complete Joint Penetration.

Q22 — Correct Answer: B

A roundtorectangular transition is a warped, doublycurved surface that cannot be exactly described by either parallel line generators (which apply to prismatic and cylindrical shapes) or radial lines from a single apex (which apply to pyramidal and conical shapes). Triangulation approximates this nondevelopable surface by dividing it into small triangular facets and developing each triangle's true shape independently, then assembling the facets into a flat pattern. A is wrong because parallel line development requires a surface generated by straight lines parallel to one another, which a roundtorectangular transition does not produce. C is wrong because radial line development requires all surface lines to converge to a single point, which this transition geometry does not have. D is wrong because "contour line development" is not a standard fabrication development method for this geometry.

Q23 — Correct Answer: D

Under ASME Section IX QW404, a change in the ANumber (deposited weld metal analysis group) is an essential variable for most welding processes. ER316L typically produces an ANumber 8 deposit (18–20% Cr, 8–12% Ni with molybdenum addition), while ER309L produces an ANumber 9 deposit (22–26% Cr, 12–14% Ni, no Mo). This compositional classification change requires a new PQR qualification test to support the amended WPS. A is wrong because sharing the same SFA specification does not exempt an ANumber change from essential variable requirements. B is wrong because the FNumber (F6 for both) governs interchangeability within a class, but ANumber is a separate and independent essential variable. C is wrong because ANumber changes are essential variables regardless of service temperature — the supplementary essential variable provision applies to impact testing, not to ANumber.

Q24 — Correct Answer: C

CSA W59 requires that weld access hole edges in dynamically loaded structural members be smooth and completely free of notches, gouges, reentrant corners, and cutting defects. These geometric discontinuities act as stress concentrators at the hole perimeter under cyclic loading, initiating fatigue cracks that can propagate into the structural member. Finish grinding to remove all surface irregularities is specified for all dynamic loading applications. A is wrong because filling the access hole with weld metal is not the code requirement — the edge quality, not the hole closure, is what CSA W59 specifies. B is wrong because edge parallelism to the flange is not the primary weld access hole quality requirement. D is wrong because no code provision requires the access hole diameter to equal the connecting plate thickness.

Q25 — Correct Answer: A

Longitudinal bowing (cambering toward the weld) results from the weld metal deposited on the upper plate surface contracting as it cools, shortening the upper surface relative to the plate's neutral axis. This differential longitudinal contraction causes the upper surface to become shorter than the lower surface, pulling both plate ends upward — the classic concave bow on the welded side. This is called longitudinal bowing and is a direct result of unrestrained longitudinal weld shrinkage after clamp release. B is wrong because transverse buckling is a lateral buckling pattern in thin plate, not the described longitudinal distortion. C is wrong because angular distortion is rotation about the weld axis (opening or closing the joint angle), not longitudinal bowing. D is wrong because hot short failure is a cracking mechanism, not a distortion mode, and does not produce the described assemblywide bowing.

Q26 — Correct Answer: D

Elongated (piping or wormhole) porosity produces dark, elongated voids with characteristically rounded ends on radiographic film. These voids form when a sustained source of contamination (moisture from a cracked coating, hydrocarbons, surface contaminants) produces continuous gas generation at a specific location in the weld pool, forming elongated bubbleshaped voids that are recorded as dark elongated zones with round ends. Their location at or near the weld centerline and irregular spacing along the weld length are consistent with a single contamination source acting at the pool during deposition. A is wrong because lack of penetration appears as a tight linear dark line at the weld root, not as roundedend elongated indications at the centerline of a multipass weld. B is wrong because lamellar tearing occurs through the base metal thickness perpendicular to the plate surface, away from the weld centerline and at a different location in the crosssection. C is wrong because cold laps produce linear indications at pass interfaces, not the roundedend elongated indications at the weld centerline described.

Q27 — Correct Answer: B

ER309L contains approximately 23–25% Cr and 12–14% Ni — significantly higher than ER308L's 19–21% Cr and 9–11% Ni. When buttering the P91 base metal surface, the dilution from P91's iron and alloy content reduces the weld deposit's Cr and Ni. ER309L's overalloyed chemistry provides the necessary margin so that even after this dilution, the deposit remains austenitic with adequate chromium and nickel for corrosion resistance and structural stability. ER308L would be pulled below minimum levels by the same dilution, making it unsuitable for this application. A is wrong because both ER309L and ER308L are "L" (lowcarbon) grades — carbon content is not the differentiating factor for this dissimilar metal application. C is wrong because ER308L can be qualified for PNumber 5B under ASME IX — the limitation is metallurgical, not administrative. D is wrong because both wires are commercially available in the small diameters used for GTAW root passes.

Q28 — Correct Answer: C

An abrupt 90degree internal corner at a weld termination creates a high stress concentration factor (Kt) at the reentrant corner geometry. Under cyclic loading, this stress concentrator promotes fatigue crack initiation at the weld toe at that corner. Adding a smooth cope radius or fillet radius at the corner reduces the Kt dramatically and extends the fatigue life of the connection detail. A is wrong because grinding cannot fix an inherent geometric stress concentration at a 90degree corner — redesign with a radius is the correct solution. B is wrong because the electrode access issue is manageable and is not the primary concern; the structural fatigue performance is. D is wrong because unequal preheat is a separate concern related to residual stress, not the primary concern created by the reentrant corner geometry under fatigue loading.

Q29 — Correct Answer: A

ASME Section IX QW451.1 specifies that for a test coupon thickness T between 4.8 mm (3/16 in.) and 19 mm (3/4 in.), the qualified production thickness range for groove welds is from T/2 minimum to 2T maximum. For T = 12 mm: minimum = 12 ÷ 2 = 6 mm, maximum = 12 × 2 = 24 mm. B is wrong because there is no universal 1.5 mm minimum thickness for SMAW in QW451.1 — the T/2 rule applies. C is wrong because T/4 is not the formula specified in QW451.1. D is wrong because production welding on material thinner than the test coupon is explicitly permitted down to T/2 under QW451.1.

Q30 — Correct Answer: D

For a two45degreeelbow parallel offset: travel distance (CtoC between elbow centrelines) = offset ÷ sin(45°) = 200 ÷ 0.707 = 283 mm. The facetoface spool length equals the centreline distance minus the takeout for each fitting: 283 − (2 × 38 mm takeout) = 283 − 76 = 207 mm. A is wrong because the travel distance does not equal the offset for 45degree fittings — the geometry requires division by sin(45°). B is wrong because takeout deductions are always required when converting from centretocentre to facetoface dimensions. C is wrong because the formula uses the reciprocal of sin(45°) as a divisor, not sin(45°) as a multiplier.

Q31 — Correct Answer: B

Under CSA W59, a prequalified joint preparation that exceeds the maximum tolerances listed in the prequalified joint tables constitutes use of an unqualified procedure. The root face must be corrected to within the specified 3 mm maximum before welding, or the joint with the actual 4.5 mm root face must be formally requalified by PQR testing at that parameter. A is wrong because CSA W59 does not provide a documentationonly path for exceeding prequalified dimensional tolerances. C is wrong because elevated preheat is not a recognized CSA W59 substitution for dimensional nonconformances in prequalified joints. D is wrong because JHSC signoff is an occupational health and safety function and has no authority to approve nonconformances in welding procedure compliance.

Q32 — Correct Answer: A

CSA W59 Clause 5.5 limits undercut on cyclically loaded structural members to 0.25 mm (0.010 in.) maximum at any weld toe subjected to dynamic or fatigue loading. A measured undercut of 0.8 mm significantly exceeds this limit and constitutes a rejectable condition requiring repair — either by adding weld metal to fill the undercut notch or by mechanical blending if the remaining plate thickness is sufficient. B is wrong because the 1/16inch (1.6 mm) limit applies to statically loaded structures, not to dynamically loaded members. C is wrong because no lengthbased exception for undercut depth exists for cyclically loaded structural members under CSA W59. D is wrong because no "conditional zone" provision in CSA W59 permits engineering disposition for undercut between 0.5 mm and 1.0 mm at dynamic connections.

Q33 — Correct Answer: C

A minimum preweld inspection for a CSA B51 registered pressure vessel joint must encompass the complete set of factors that could directly compromise weld quality or code compliance: (1) joint preparation dimensions verified against the WPS, (2) base metal identity confirmed against the material test report, (3) joint surface condition verified for cleanliness and freedom from contaminants, and (4) preheat confirmed at or above the WPS minimum. Each item must be documented before the first arc is struck. A is wrong because fitup geometry alone is insufficient for codecompliant preweld inspection. B is wrong because temperature and heat number alone do not constitute a complete preweld inspection. D is wrong because restricting the inspector's role to consumable identification only fails to satisfy the full scope of preweld inspection required for registered pressure vessels.

Q34 — Correct Answer: D

A radiographic film with density below the minimum required range (2.0–3.5 in this case) is technically unsatisfactory and must be reshot. A film density below the minimum means insufficient contrast and sensitivity to reliably resolve the minimum rejectable flaw size the code requires to be detected. Defects may be present and invisible at this exposure level. A is wrong because no ±25% tolerance or ±0.3 densityunit tolerance is provided for films below minimum density — the minimum boundary is hard. B is wrong because ASME Section V does not permit acceptance of subminimum density films on the basis of apparent IQI performance — the film must first meet the density specification. C is wrong because densitometer recalibration is not the first or correct step — the film result is invalid regardless of instrument calibration, and the retake proceeds.

Q35 — Correct Answer: B

Material traceability for registered pressure vessels requires a direct documented link between each plate and its mill test report. If the original heat number marking was lost during cutting, that link is broken and cannot be restored by inference or visual examination alone. The plate's compliance must be reestablished through chemical analysis and hardness testing (and any other required verification per the applicable standard) before it can be incorporated into the vessel. A is wrong because thickness measurement confirms only dimensional compliance, not material grade or chemistry. C is wrong because individual plate identification is a distinct requirement from batchlevel MTR traceability — one batch MTR does not reidentify individual plates whose markings have been lost. D is wrong because visual identification of steel plate by experienced inspectors is not an accepted material identification method for any registered pressure vessel code.

Q36 — Correct Answer: A

Depositing both webside fillets simultaneously using two welders, then both flangeside fillets simultaneously, applies equal and opposing thermal shrinkage forces symmetrically about the column's neutral axis. The simultaneous symmetric application prevents the cumulative unbalanced distortion that sequential welding produces. B is wrong because sequential clockwise welding creates a progressive unbalanced shrinkage path around the column, tending to rotate the assembly in the welding direction. C is wrong because completing each full fillet before moving to the next allows the maximum unbalanced shrinkage from each weld to act before a counteracting weld is deposited. D is wrong because welding shorter welds first has no documented distortion reduction benefit for base plate attachment — the simultaneous balanced approach is the established best practice.

Q37 — Correct Answer: C

A break symbol on a pipe isometric drawing indicates that the run of pipe continues beyond what is visible on the current drawing sheet — the drawing sheet edge or space limitation forces the continuation to an adjacent sheet referenced in the drawing set. The "open pipe end" representation beyond the break is a drawing convention, not an actual physical pipe end. The spool continues with additional components shown on the next sheet. A is wrong because material specification changes between pipe segments are communicated by material break symbols and specification notes, not by break line symbols. B is wrong because weld joint locations use distinct weld symbols (circles, gaps) on piping isometrics, not break line symbols. D is wrong because expansion loop locations are indicated by specific loop geometry drawn on the isometric, not by break line symbols.

Q38 — Correct Answer: D

Punching holes in structural steel introduces cold work and compressive residual stresses in an annular zone around each hole. When welding heat is applied within a critical distance of these coldworked zones, the thermal cycle can produce a susceptible HAZ microstructure — particularly in higherCE or higherstrength steels where the combination of existing cold work damage and weldthermalcycleinduced microstructural changes elevates cold cracking risk. A is wrong because a 40 mm minimum distance rule related to magnetic flux concentration for arc blow is not a recognized code provision. B is wrong because CSA W59 does not specify a 50 mm mandatory minimum holetoweld distance for fillet welds. C is wrong because a mandatory 600°C stress relief for punchedhole proximity is not a standard code requirement for structural fabrication.

Q39 — Correct Answer: A

The 6GR (6G with restriction ring) qualification is the most comprehensive pipe weld certification available under CWB standards. Qualifying in 6GR provides coverage for all groove weld positions on pipe — 1G, 2G, 5G, and 6G — and also provides groove weld coverage on plate in all positions. The restriction ring represents the most physically demanding access condition, and qualifying in it demonstrates competence that covers all lessdemanding configurations. B is wrong because the coverage extends well beyond just 6G and 6GR. C is wrong because the 6GR qualification does extend to plate groove welds in all positions under CWB standards. D is wrong because the 6GR qualification is not restricted by the test pipe diameter in the manner described.

Q40 — Correct Answer: B

HI = (V × A × 60) ÷ (speed mm/min × 1,000) = (36 × 700 × 60) ÷ (600 × 1,000) = 1,512,000 ÷ 600,000 = 2.52 kJ/mm. This is well below the WPS maximum of 4.0 kJ/mm, confirming the production parameters are within the qualified procedure limit. A is wrong because the denominator of 360,000 is incorrect — the denominator is travel speed (600) multiplied by 1,000, not by 600. C is wrong because the arithmetic in that option uses an incorrect formula derivation. D is wrong because amperage is a multiplier, not a divisor, in the numerator of the heat input formula.

Q41 — Correct Answer: C

Dry magnetic particle powder is the appropriate choice for coldweather inspections at 2°C. The dry powder is not susceptible to freezing or viscosity increase at temperatures at or near freezing, and it retains the magnetic mobility needed to migrate to flux leakage sites at the defect location. Wet suspension fluids can freeze or become excessively viscous at low temperatures, preventing the particle mobility that is essential for defect detection. A is wrong because dry particles — not wet — are the recommended coldweather method; wet methods are the ones restricted at or near freezing. B is wrong because MT examinations can be performed below 5°C using the dry method, with appropriate qualification. D is wrong because glycolbased antifreeze suspensions may help at lower temperatures, but fluorescent wet particle testing as the universal coldweather solution is not the standard recognized answer.

Q42 — Correct Answer: D

ASME Section VIII Division 1 establishes mandatory steps for weld repairs: (1) remove the defective area and verify complete removal by NDE, (2) use a qualified WPS executed by a qualified welder, (3) reexamine the completed repair using the original examination method applied to the same acceptance criteria as the original production weld. All three elements are required. A is wrong because thermal removal methods (CACA, grinding) are permitted for pressure vessel weld repair excavation. B is wrong because visual inspection alone of the repair excavation is not sufficient — NDE must confirm complete defect removal before repair welding begins. C is wrong because informal authorization without a qualified WPS and welder is completely unacceptable under ASME VIII for registered vessel repairs.

Q43 — Correct Answer: A

E480XXH8 meets and exceeds the minimum E480XX specification stated in the drawing. The H8 designation confirms an additional level of quality control — the electrode has been tested to demonstrate diffusible hydrogen at or below 8 mL/100g of deposited weld metal — while still producing the same minimum tensile and yield properties as E480XX. A more stringently tested product in the same strength class may always substitute for the base classification without formal engineering approval. B is wrong because the H8 designation does not meaningfully change arc stability characteristics to a degree that affects structural weld quality. C is wrong because H8 is an additional quality designation appended to the base strength class, not a separate strength class designation under CSA W48. D is wrong because the H8 designation does not alter deposition efficiency by 15% — it controls the hydrogen test result only.

Q44 — Correct Answer: B

High joint restraint increases the triaxial residual tensile stress in the HAZ during cooling. This elevated residual stress, combined with any diffusible hydrogen present in the weld metal, dramatically increases cold cracking susceptibility above what the standard preheat table accounts for (which is developed for freetoshrink or lightly restrained joints). Increasing the preheat from 50°C to 100°C provides a slower cooling rate through the martensite start temperature range and prolongs the time available for diffusible hydrogen to escape before the temperature drops too low for hydrogen mobility — both effects directly address the elevated restraintinduced cold cracking risk. A is wrong because heavy W sections are comparable to plate in heat retention characteristics and do not specifically require 100°C for that reason. C is wrong because Grade 350W at 50 mm with CE = 0.42 does not automatically trigger 100°C in the standard CSA W59 table — the engineer's note is applying engineering judgment beyond the table. D is wrong because lamellar tearing is a throughthickness base metal fracture mechanism related to sulfide inclusion planes and throughthickness stress — it is not specifically addressed by a 100°C preheat.

Q45 — Correct Answer: C

In ASME B31.3, the minimum required wall thickness equation includes the weld joint quality factor E in the denominator alongside the allowable stress (t = PD ÷ [2(SE + Py)]). A lower E factor of 0.80 reduces the product SE, effectively reducing the allowable stress for design purposes. To maintain the same safety factor, either the wall thickness must be increased proportionally or the maximum allowable operating pressure must be reduced. The code accounts for the higher statistical probability of undetected defects in unexamined welds through this reduction factor. B is wrong because the E factor appears directly in the design equation and affects the pressure design calculation, not only inspection frequency. D is wrong because the weld joint quality factor is explicitly part of the B31.3 pressure design formula and directly governs the wall thickness requirement.

Q46 — Correct Answer: A

ASME Section VIII Division 1, paragraph UG99, specifies that the minimum hydrostatic test pressure is 1.3 times the MAWP (adjusted for temperature differences between test and design conditions). For MAWP = 3,500 kPa: minimum test pressure = 1.3 × 3,500 = 4,550 kPa. The test is conducted above MAWP to verify structural integrity of the completed vessel — including all weld joints, flanges, and nozzles — under conditions exceeding the design maximum, confirming no leaks, yielding, or deformation before service. B is wrong because ASME VIII Division 1 specifies the 1.3× factor, not

1.5×. C is wrong because the 1.3× factor applies to all vessels under ASME VIII Div 1 regardless of fluid phase. D is wrong because testing at MAWP only is not the ASME VIII hydrostatic test requirement.

Q47 — Correct Answer: D

When a new fillet weld terminates directly on an existing fillet weld, the crater at the termination point must be filled and tapered to blend smoothly with the existing weld surface. An abrupt termination creates a geometric notch at the exact boundary of old and new weld metal that acts as a stress concentrator and potential crack initiation site. The arc must not be extinguished at the sharp interface — the transition must be gradual and smooth. A is wrong because no welding code imposes a minimum 50 mm setback or prohibits new welds from contacting existing weld metal. B is wrong because standard crater fill alone is insufficient for this application — the specific concern is the notch geometry at the oldtonew interface. C is wrong because option C describes grinding the existing weld to a feather edge, which while helpful does not address the arc termination technique during deposition that is the specific concern here.

Q48 — Correct Answer: B

The electrode heat number H20234421 is the direct traceability link between the specific weld deposit at joint PV112 and the electrode manufacturer's quality records. The heat (lot) number uniquely identifies the production batch, allowing retrieval of the manufacturer's chemical composition certificate, mechanical test records, and diffusible hydrogen test data for that exact lot — precisely the documentation needed in a postservice failure analysis to characterize the deposited metal chemistry. A is wrong because the WPS number provides the electrode classification type and process parameters but not the specific lot chemistry for the material actually used. C is wrong because the PT acceptance record documents surface condition at the time of fabrication, not the deposit chemistry. D is wrong because the welder ID links to training and qualification records — not to the deposited metal's chemical lot.

Q49 — Correct Answer: C

To divide one pipe length into three pieces, only two cuts are required (not three or four). Each cut creates a 4 mm kerf. Total kerf loss = 2 cuts × 4 mm = 8 mm. Material required = (3 × 650 mm) + 8 mm = 1,958 mm. Since 1,958 mm is less than the available 2,000 mm, three 650 mm pieces can be produced with 42 mm of material remaining. A is wrong because the calculation used three cuts — cutting one pipe into three pieces requires only two cuts. B is wrong for the same reason — three cuts are not required. D is wrong because calculating kerf loss based on six cut faces is not the correct methodology — each cut produces one kerf, consuming one kerfwidth of material.

Q50 — Correct Answer: A

HighCE steels (0.85 CE) airharden very rapidly during the fast cooling that follows OFC. Preheating to 200–250°C before and throughout the cutting operation slows the cooling rate of the HAZ through the martensite transformation range, reducing hardness. After cutting, the piece must be allowed to slowcool under an insulating blanket or in a furnace to prevent the rapid postcut quench that would otherwise create hard, cracksusceptible martensitic microstructures along the entire cut length. B is wrong because flux paste does not provide thermal control adequate for a CE of 0.85 material. C is wrong because increasing oxygen pressure increases cutting speed, which actually reduces the preheat soak time — it does not control the metallurgical transformation. D is wrong because water quenching would dramatically worsen martensite formation in highCE steel, creating exactly the cracking problem the protocol must prevent.

Q51 — Correct Answer: B

PAC is the correct process for cutting copper. OFC relies on an exothermic iron oxidation reaction to sustain the cut — the cut begins with iron igniting and the oxidation energy propagates the cut forward. Copper's thermal conductivity is approximately 400 W/m·K (compared to ~50 W/m·K for structural steel), which conducts heat away from the cutting zone far faster than the reaction can supply it. PAC delivers arc energy independently of the base metal's chemical properties and cuts copper and other nonferrous metals regardless of their thermal conductivity. A is wrong because OFC absolutely cannot cut copper — copper's thermal conductivity prevents the reaction from sustaining regardless of tip selection or preheat. C is wrong because PAC does successfully cut copper in a standard shop environment. D is wrong because copper oxide (Cu_2O/CuO) does not support the same cutting mechanism as iron oxide, and OFC fails on copper for the stated metallurgical and thermal reasons.

Q52 — Correct Answer: D

When standoff distance exceeds the specified range, the plasma jet diverges before reaching the plate surface. This divergence distributes the plasma energy over a wider area at the top entry zone while the lower kerf zone receives less energy from the spreading plasma column — producing a kerf that is wider at the top than at the bottom, which is the definition of a negative bevel (inverted taper). A is wrong because excessive travel speed causes the arc to trail backward and produces a forward drag on the cut face, not a negative bevel. B is wrong because insufficient amperage reduces overall cutting energy and affects penetration depth, but does not specifically cause the inverted taper pattern characteristic of excessive standoff. C is wrong because standoff too close typically concentrates energy too narrowly at the top, which can affect kerf geometry but produces the opposite taper pattern from what is described.

Q53 — Correct Answer: A

Tip No. 4 is rated to a maximum of 75 mm — meaning it is designed to deliver the minimum adequate cutting oxygen flow for this plate thickness at its operational limit. At this maximum rated thickness, the cut will be acceptable under optimal conditions but has no margin for slight deviations such as marginally lower gas pressure, slightly elevated travel speed, or minor tip wear. Using Tip No. 5 (rated 75–100 mm) at the lower end of its range provides a meaningful performance margin. B is wrong because the tip is rated to 75 mm maximum — it can make the cut under good conditions. C is wrong because a smaller orifice does not produce higher cutting speed at the same regulator pressure on thick plate. D is wrong because the two tips are not equivalent at 75 mm plate — Tip No. 4 is at its operational limit while Tip No. 5 has significant reserve capacity.

Q54 — Correct Answer: C

The established CACA guideline is that the groove width produced approximately equals the electrode diameter used. For a required groove width of 12 mm, a 12 mm (approximately 1/2inch) diameter electrode is the appropriate selection. The required 8 mm groove depth is then achieved through the combination of electrode angle, travel speed, and amperage settings rather than electrode diameter. A is wrong because a 6.4 mm electrode would produce approximately 6.4 mm groove width, requiring two overlapping passes rather than a single pass for the 12 mm requirement. B is wrong because selecting an electrode larger than the groove width is unnecessary and would produce excessive material removal. D is wrong because electrode diameter controls groove width, not groove depth — depth is controlled by technique parameters.

Q55 — Correct Answer: B

Cast iron contains 2–4% carbon and approximately 1–3% silicon. During the OFC process, the silicon present at the cutting front reacts with oxygen to form silicon dioxide (SiO_2). SiO_2 has a melting point of approximately 1,700°C — well above the iron ignition temperature of approximately 870°C. The refractory SiO_2 slag forms at the cutting front before the iron can fully oxidize, physically blocking the cutting oxygen stream from reaching fresh iron and preventing the exothermic reaction from propagating through the material. A is wrong because no abnormal oxygen pressure is required — the silicon chemistry is the fundamental barrier, not a pressure deficiency. C is wrong because the failure is not caused by inadequate preheat temperature but by the refractory silica chemistry that prevents the reaction regardless of preheat. D is wrong because cast iron has similar thermal conductivity to steel, not significantly lower, and this is not the mechanism causing OFC failure.

Q56 — Correct Answer: A

Gradual quality deterioration beginning before the scheduled replacement interval at 200 cuts (50 cuts early) indicates that the specific production conditions — material, thickness, amperage, and cycle frequency — are wearing the consumables faster than the nominal specification derived under the manufacturer's test conditions. The scheduled cut count is a guide, not a guarantee for all conditions. When quality deteriorates before the scheduled interval, the correct response is to replace consumables immediately and adjust the planned interval for this application. B is wrong because quality deterioration significantly before the scheduled interval is not within "normal variation" — it signals abovenormal wear rate requiring earlier action. C is wrong because the early deterioration indicates the consumable life prediction is not accurate for these conditions, not that it is confirmed. D is wrong because gradual deterioration progressively worsening over 50 cuts is the characteristic pattern of cumulative electrode and nozzle wear, not a standoff distance calibration problem which would be consistent across all cuts.

Q57 — Correct Answer: D

Elevated OFC work generates a severe falling hazard — ejected slag can travel significant distances downward, and large cut steel sections can fall and strike personnel below. The additional controls required at elevation include: physical exclusion barriers below the work zone, a fire watch positioned at ground level monitoring for falling material and fire risk, and a communication system linking the elevated operator with groundlevel personnel. A is wrong because gas cylinders may remain at ground level with hoses properly routed — there is no 3metre vertical hose limit in standard regulations. B is wrong because elevation does not change the flame characteristics of the cutting torch in the manner described. C is wrong because elevation does introduce specific additional hazards — falling cutting byproducts and cut sections — that require controls beyond the standard groundlevel procedure.

Q58 — Correct Answer: C

CACA electrodes are made of carbon graphite. The arc deposition process transfers carbon from the electrode into the groove surface through arc diffusion, creating a carburized layer on the excavated surface. For 316L stainless steel repair, this carbonenriched layer would contaminate the lowcarbon repair weld deposit, promoting sensitization and reducing intergranular corrosion resistance. Grinding to remove 1–2 mm of material eliminates this carburized zone and exposes clean, unaffected stainless base metal for the repair weld. A is wrong because passivation is a postfabrication corrosion protection treatment, not a preweld surface preparation step. B is wrong because there is no standard "antiflux compound" procedure for stainless steel CACA repair preparation. D is wrong because wire brushing alone does not remove the carburized layer — grinding is necessary for weld preparation of CACA grooves in stainless steel.

Q59 — Correct Answer: B

Parameters optimized for 25 mm plate use a travel speed appropriate for the higher thermal mass of thick plate — a speed that results in excessive heat accumulation on the thin plate crosssection. The prolonged heat exposure melts both sides of the kerf irregularly. Increasing travel speed limits the heat input per unit length on 6 mm plate, preventing thermal spread and producing a cleaner, more controlled cut face. A is wrong because increasing the preheat flame further increases the already excessive heat input on thin plate, worsening the problem. C is wrong because using an undersized tip is not the recognized technique correction for thin plate OFC. D is wrong because reducing cutting oxygen pressure below specifications risks incomplete penetration of the cut and does not address the heat input issue.

Q60 — Correct Answer: A

A water table below a mechanized PAC system provides four major integrated benefits: (1) fume and particulate suppression — cutting byproducts are captured below the plate surface rather than rising into the work environment; (2) significant noise reduction — water absorbs the highdecibel plasma cutting sound; (3) thermal management of the cut plate — water cooling reduces thermal distortion; and (4) control of spark and slag ejection below the work. These combined benefits simultaneously address occupational health, hearing hazard, dimensional quality, and fire risk. B is wrong because increased cutting speed from nozzle cooling is a secondary benefit, not the primary justification. C is wrong because water does not provide supplemental electrical grounding for plasma power sources in the manner described. D is wrong because the water table does not chemically enable cutting of materials that cannot otherwise be plasmacut.

Q61 — Correct Answer: D

After an extended idle period, air can infiltrate through check valves into the hose circuits. Both hoses must be purged separately with their own gas before lighting to ensure each circuit contains only the correct gas. Purging the oxygen hose first (opening only the oxygen needle valve) then separately purging the fuel gas hose (opening only the fuel needle valve) eliminates any airfuel or airoxygen mixtures inside the hoses before ignition. A is wrong because running only oxygen for 30 minutes does not address the fuel gas hose and creates an oxygenenriched shop atmosphere. B is wrong because lighting immediately without purging risks igniting airfuel mixtures inside the fuel hose. C is wrong because new hoses require the same purging procedure; the assertion that they are shipped in a perfectly gastight sealed condition that precludes any air contamination is not accurate.

Q62 — Correct Answer: C

For OFC of structural steel (nonprecision applications), a drag of approximately 10–15% of plate thickness is considered normal and acceptable. A 4 mm drag on 40 mm plate represents 10%, which is within the normal range. The sharp top edge (no rounding or topsurface melting) and uniformly smooth cut face confirm that preheat, travel speed, and oxygen pressure are all correctly set. A is wrong because a 10% drag does not require a travel speed reduction — it is within the accepted quality range. B is wrong because 10% drag is normal and does not constitute a condition requiring rework before weld preparation. D is wrong because smooth cut face with modest drag is not indicative of insufficient cutting oxygen — insufficient oxygen typically produces rough, irregular cuts with heavy trailing dross.

Q63 — Correct Answer: B

Argon/H35 (35% hydrogen, 65% argon) plasma produces the highest plasma temperature and enthalpy for aluminum cutting. The reducing hydrogen atmosphere in the plasma column actively suppresses aluminum oxide formation at the cut face during the cutting cycle, producing bright, lowoxide cut edges that can be welded with minimal surface preparation. Air plasma produces heavy oxide contamination and nitrogen absorption. Nitrogen plasma is intermediate — better than air but inferior to H35 for weldready aluminum edges. A is wrong because compressed air plasma produces the most contaminated cut edges on aluminum, not the cleanest. C is wrong because nitrogen plasma is superior to air but does not provide the weldquality surface that H35 delivers. D is wrong because pure argon plasma provides a lowerenergy plasma column than H35 and produces lowerquality cuts on aluminum without the reducing benefit of the hydrogen addition.

Q64 — Correct Answer: A

When one orifice out of five produces an extended carburizing feather while the others are neutral, that specific orifice is receiving proportionally less oxygen than the others. This oxygen deficiency relative to fuel creates a locally carburizing condition at that orifice, producing the extended white feather while adjacent orifices remain neutral. A partial blockage in that specific orifice passage is the most probable cause, and it must be cleared with an appropriate tip cleaner and verified before cutting begins. B is wrong because a supply pressure deficiency would affect all five orifices simultaneously — not produce a single abnormal flame while four remain normal. C is wrong because singleorifice flame abnormality is not a recognized warmup behavior; it indicates a specific blockage condition. D is wrong because a microfracture causing one flame to behave abnormally while four are normal is a less probable cause than a simple blockage, and a fractured tip body would typically show gas leakage at the fracture location rather than affecting only the combustion character.

Q65 — Correct Answer: C

The correct PAC midcut restart procedure is: (1) position the torch 3–5 mm before the interruption point along the alreadycompleted portion of the cut (in the open kerf), (2) restart the arc in that open kerf space to avoid consumable shock from restarting in solid material, (3) allow the transferred cutting arc to stabilize fully, then (4) advance through the interruption point and continue the cut in the programmed direction. A is wrong because returning to the plate edge and restarting from scratch wastes production material and time unnecessarily. B is wrong because restarting the arc directly at the interruption point subjects the consumables to the worst possible restart condition — against partiallysolidified kerf material. D is wrong because advancing ahead of the interruption into uncut material creates a gap that will produce a doublecut overlap and noncontinuous kerf geometry.

Q66 — Correct Answer: D

The correct purging sequence for new or idle hose connections is to purge each circuit separately with its own gas. Open the oxygen needle valve briefly to fill the oxygen hose with oxygen, close it; then open the fuel needle valve briefly to fill the fuel hose with fuel gas, close it. This ensures each hose contains only the correct gas before the torch is lit, preventing any airfuel or airoxygen explosive mixture from existing inside the hoses at the moment of ignition. A is wrong because simultaneous purging of both circuits risks crosscontamination between the circuits if any check valve is not fully sealed. B is wrong because purging fuel first before oxygen is not the standard sequence and risks fuel vapors entering the oxygen circuit. C is wrong because even new hoses can contain air and require purging before use — the premise of airtight sealed shipping is not reliable in all cases.

Q67 — Correct Answer: B

Groove depth in CACA is primarily controlled by two operatormanaged technique parameters: (1) electrode angle from the work surface — a steeper angle (closer to vertical) directs the arc more deeply into the base metal, producing a deeper groove; and (2) travel speed — slower travel speed allows more arc time per unit length, increasing the arc's excavation depth. Maintaining consistent angle and speed throughout the operation is the basis for achieving consistent groove depth to the ±1.5 mm tolerance specified. A is wrong because while electrode diameter affects groove width, it does not directly set groove depth — depth is a function of angle and speed. C is wrong because although amperage and diameter influence the groove crosssection, the operator controls depth primarily through angle and travel speed adjustments during the operation. D is wrong because arc voltage alone is not a reliable depth control parameter — the electrodetowork distance relationship (which creates voltage) must be managed through angle adjustment, not as an independent voltage control.

Q68 — Correct Answer: A

For cutting 304L stainless steel where the cut edges must be weldready, nitrogen plasma gas with nitrogen shielding provides a clean, bright cut face with significantly less chromium oxide discoloration than air plasma. The nitrogen plasma provides sufficient energy for clean cutting while the nitrogen atmosphere reduces oxidation of the chromiumcontaining stainless surface during the cutting cycle. B is wrong because CO_2 shielding on stainless steel would produce oxidized cut edges rather than the described protective chromiumCO_2 complexes — that mechanism is not established for stainless PAC. C is wrong because oxygen plasma dramatically oxidizes the stainless steel cut surface, making it the worst choice for a weldready application. D is wrong because compressed air shielding after H35 plasma would oxidize the hot cut face as the air contacts the cooling stainless surface, counteracting the clean plasma cutting achieved by H35.

Q69 — Correct Answer: C

When both the cylinder valve and the torch needle valve are closed, the sealed delivery circuit should maintain constant pressure. A slowly creeping pressure increase over 5 minutes with no gas source connected to the circuit indicates that gas is leaking through the highpressure seat of the regulator from the highpressure side into the lowpressure delivery side. This regulator seat leak is a malfunction requiring removal from service and repair by a qualified technician. A is wrong because thermal expansion of trapped gas would occur rapidly as the hose warms and would quickly stabilize — it would not creep steadily over a 5minute observation period. B is wrong because gas cannot permeate inward through a properly rated oxygen hose wall against the pressure differential. D is wrong because barometric pressure changes cannot be transmitted into a sealed highpressure gas circuit through a regulator diaphragm in any meaningful way.

Q70 — Correct Answer: D

The correct PAC shutdown sequence is to complete the final production cut, allow the postflow cooling gas cycle to run to full completion (protecting the electrode, nozzle, and shield from residual arc heat), and only then turn off the power source and close the gas supply valves. Cutting the gas flow while the torch body is still hot removes the only active cooling protecting the consumables from thermal damage during the cooldown period. A is wrong because turning off the power source before gas flow cease removes the arc but leaves the hot torch without its cooling gas protection. B is wrong for the same reason — closing gas before power removes cooling while the torch is still hot. C is wrong because completely venting all pressurized gas through the torch nozzle is not the standard shutdown procedure and could cause unnecessary wear on the nozzle exit geometry.

Q71 — Correct Answer: B

Propane can achieve comparable cut quality to acetylene on structural plate thicknesses above approximately 12 mm when used with tips specifically designed for propane's different heat release profile and flame geometry. For the 25–100 mm range in highvolume structural production, propane's higher heat content per cubic metre, lower delivered cost per unit of energy, and inherent safety advantages (no explosive instability hazard above 103 kPa that acetylene carries) make it economically competitive. A is wrong because propane is fully capable of cutting structural plate above 20 mm with the correct tips — this claim overstates the limitation. C is wrong because meaningful performance differences exist between the two fuels, especially regarding preheat time on thin plate and flame temperature, so selection purely on price is an oversimplification. D is wrong because acetylene has the higher maximum flame temperature (approximately 3,480°C vs. propane's approximately 2,820°C in oxygen) — propane's advantage is in its secondary flame heat content, not primary flame temperature.

Q72 — Correct Answer: A

E6013 electrodes use a rutile (TiO_2based) coating that produces a soft, stable arc, a fluid easilyremoved slag, excellent bead appearance, and easy reignition. These characteristics make E6013 ideal for sheet metal, light structural fabrication, and training applications. Their limitations for structural use are clearly defined: lower penetration than the deeppenetrating cellulosic E6011, and higher diffusible hydrogen than the basic lowhydrogen E7018, making them unsuitable for thicksection or highrestraint structural joints. B is wrong because E6013 produces lower penetration than E6011 — the cellulosic coating of E6011 generates a forceful, deeply penetrating arc. C is wrong because E6013 is not a lowhydrogen electrode — it produces diffusible hydrogen levels significantly above the H8 and H4 classifications of E7018. D is wrong because E6013 can be used on both AC and DC power sources, though its easyionization rutile coating is particularly suited to AC.

Q73 — Correct Answer: C

The general guideline for electrode diameter selection for fillet welds is that the electrode diameter should approximate onehalf the specified leg size. For an 8 mm leg: 8 ÷ 2 = 4 mm electrode. The standard amperage range for 4.0 mm E7018 electrodes is 150–170 A, which is appropriate for the 3F (horizontal) position on 10 mm structural plate at this leg size. A is wrong because 2.5 mm is significantly undersized for an 8 mm leg and would require multiple passes. B is wrong because a 6.4

mm electrode at 320 A is excessive for a singlepass 8 mm fillet and would cause distortion and oversized beads. D is wrong because 3.2 mm is slightly undersized for an 8 mm leg per the guideline, and 95 A is below the recommended range even for 3.2 mm E7018.

Q74 — Correct Answer: D

Sensitization in austenitic stainless steel is the precipitation of chromium carbides ($Cr_{23}C_6$) at austenite grain boundaries when the material is held in the sensitization temperature range of approximately 425–870°C for sufficient time. Chromium is depleted from the zone adjacent to the carbide precipitates, leaving areas vulnerable to intergranular corrosion. In multipass welding, each pass heats the HAZ of prior passes through this range; a maximum interpass temperature limit reduces the time each HAZ location spends in the sensitization range during the complete welding cycle. A is wrong because sensitization is not austenitetomartensite transformation — these are entirely different metallurgical phenomena. B is wrong because sigma phase precipitation is a separate phenomenon requiring higher temperature exposure and different conditions from carbide sensitization. C is wrong because dilution reducing chromium content is not the definition of sensitization.

Q75 — Correct Answer: B

Even when the arc is active and producing heat at the leading weld pool, the cold base metal at the joint ends continuously conducts heat away from the alreadydeposited weld metal at those locations. On a thick plate in cold ambient conditions, the cold plate end can act as a heat sink strong enough to cool the HAZ of the justcompleted weld deposit through the martensite transformation range at a rate exceeding the cold cracking threshold — even while preheat is actively maintained at the start location. Maintaining preheat across the full joint prevents this coldend quench effect regardless of where the arc is positioned. A is wrong because intermittent cooling below preheat temperature does not permanently reduce yield strength — this is a fabrication concern about cracking risk, not a permanent property change. C is wrong because the concern is cold cracking risk and excessive cooling rate, not magnetite formation. D is wrong because cold end quench risk applies to all passes, not just root and first fill.

Q76 — Correct Answer: A

Cast iron welding with ENiCI requires the combined technique of: short passes (30–40 mm) to limit total heat input per welding cycle; immediate hot peening of each pass while the weld metal is still warm and ductile enough to respond, mechanically relieving the contraction stresses before the brittle cast iron is forced to carry them; and controlled interpass cooling to approximately 50°C to prevent the HAZ from quenching too rapidly through the martensite formation temperature range. Together these three practices minimize thermal gradient, control HAZ hardening, and eliminate the primary cracking forces. B is wrong because a single highamperage pass creates maximum thermal shock and the worst possible martensite formation in the HAZ — the opposite of best practice for cast iron. C is wrong because 650°C preheat for cast iron is impractical, causes massive distortion, and is far beyond the established preheat range for ENiCI repair welding. D is wrong because wide weave increases the total heat input per pass and the associated thermal gradient, increasing rather than decreasing cracking risk in cast iron.

Q77 — Correct Answer: C

E7018 lowhydrogen electrodes depend on their fully intact basic coating to physically exclude atmospheric moisture from the hygroscopic flux ingredients ($CaCO_3$, CaF_2, and related compounds). Cracks in the coating expose these moistureabsorbing ingredients to ambient humidity, allowing water uptake that increases diffusible hydrogen well above the H4 or H8 classification limit. This defeats the fundamental purpose of the lowhydrogen classification. Cracked electrodes must be reconditioned at 260–430°C for minimum 1 hour or discarded, per the applicable code requirements. A is wrong because cracked coatings reduce conductivity somewhat but the primary and more critical concern is hydrogen control, not arc stability. B is wrong because the cracked coating on a lowhydrogen electrode is a disqualifying defect for structural use, not a cosmetic issue. D is wrong because overdrying produces different physical changes and behaviors — cracking from moisture exposure is a distinct mechanism with a distinct remedy.

Q78 — Correct Answer: D

E6010 electrodes are specifically designed and classified for DCEP (electrode positive, reverse polarity). When mistakenly connected to DCEN (electrode negative, straight polarity), the energy distribution in the arc is incorrect for the cellulosic coating chemistry. The result is the characteristic combination of shallow penetration (because less energy reaches the base metal on DCEN), severe arc instability, and wide, heavy spatter. A is wrong because long arc length does produce instability but the described specific combination of symptoms at confirmed correct amperage more strongly suggests polarity error.

B is wrong because E6010 cellulosic electrodes must never be stored in hot ovens — they rely on controlled moisture in the coating — but the described symptom pattern is characteristic of a polarity error. C is wrong because travel speed affects bead width and fusion depth but would not produce the type of arc instability and spatter described while amperage is confirmed correct.

Q79 — Correct Answer: B

At the 3 o'clock (side) position on 5G fixed pipe, gravity acts laterally on the weld pool and the keyhole, tending to pull the molten root metal downward away from the top side of the root gap. This gravitational pull reduces root penetration asymmetrically. A brief pause at this position combined with a slight oscillating motion builds additional heat and metal volume at the root before travel resumes, compensating for the gravitational effect and reestablishing the required keyhole geometry. A is wrong because arc blow at the 3 o'clock position may occur but the specific correction for insufficient root reinforcement is the pauseandoscillate technique, not arc length reduction. C is wrong because adjusting amperage between clock positions is not standard practice — consistent parameters with technique adaptation is the accepted approach for 5G welding. D is wrong because switching travel direction for individual segments of a pipe circumference would produce irregular, nonuniform welds.

Q80 — Correct Answer: A

When all clamps are released simultaneously after the final pass, the accumulated longitudinal thermal shrinkage from all passes is free to act at once. If the weld has cooled unevenly along the joint (one end still warmer than the other at clamp release time), the differential shrinkage magnitudes at the two ends create a net bowing force. The hotter end has not yet fully contracted, and the cooler end has — the released asymmetric shrinkage produces the observed bow. Sequential release or maintaining restraint through PWHT distributes the release of shrinkage forces more uniformly. B is wrong because rigid strict alternating of every single pass is a best practice but the described failure mode is about the clamp release sequence, not the pass sequencing directly. C is wrong because the cap pass is one contributor to distortion, not the exclusive governing factor. D is wrong because magnetic arc blow produces arc quality issues during welding, not a structural distortion pattern visible after clamp release.

Q81 — Correct Answer: C

Under AWS D1.1 and ASME IX, E7018 lowhydrogen electrodes that have been exposed to atmospheric humidity must be reconditioned at 260–430°C for a minimum of 1 hour to drive absorbed moisture from the basic coating before use. This elevated reconditioning temperature is required because the basic coating absorbs moisture too deeply for the holding oven temperature (120–150°C) to drive it out. The number of permissible reconditioning cycles before mandatory disposal follows the electrode manufacturer's specific guidance. A is wrong because the holding oven temperature of 120–150°C is insufficient to remove deeply absorbed moisture from a basic coating — reconditioning requires 260–430°C. B is wrong because E7018 H4 electrodes do not have unlimited atmospheric exposure tolerance — they have specific maximum exposure limits (4 hours for H4 class under AWS D1.1). D is wrong because reconditioning is specifically provided for in the applicable codes and is permitted before disposal is required.

Q82 — Correct Answer: D

Delta ferrite (FN 4–12) prevents solidification hot cracking in austenitic stainless deposits through a specific metallurgical mechanism. Fully austenitic weld metal solidifies through a singlephase (austeniteonly) path, which concentrates lowmelting impurities — particularly sulfur and phosphorus compounds — at austenite grain boundaries as a continuous liquid film during the final stages of solidification. When the solidification contraction stresses pull on this liquid film, it tears, creating hot cracks. Delta ferrite disrupts the continuity of this liquid film at grain boundaries by introducing a second phase that interrupts the segregation path and prevents the continuous liquid from forming. A is wrong because FN does not control arc stability. B is wrong because sigma phase from delta ferrite requires extended exposure at 650–900°C — not within 5 years at ambient temperature in most service conditions. C is wrong because FN is not a measure of base metal dilution.

Q83 — Correct Answer: B

For 4140 Q&T steel at 48 HRC, the appropriate PWHT is a stress relief at approximately 600–650°C — below the original tempering temperature of approximately 650–700°C. This temperature range is high enough to reduce residual welding stresses and temper hard martensite that formed in the HAZ during the weld thermal cycle, but low enough to prevent significantly overtempering the surrounding Q&T base metal and reducing it below its service strength requirement. A is wrong because E12018M's low hydrogen content reduces cold cracking risk but does not eliminate the HAZ martensite that forms during the weld thermal cycle — PWHT is still needed. C is wrong because full reheat treatment (requench and retemper) is not universally required for all Q&T welds above 40 HRC — stress relief below the tempering temperature is the standard approach for repair welding. D is wrong because 730°C for alloy steel is the general ASME B31.1 PWHT temperature, but it would significantly overtemper 4140 Q&T base metal below its service hardness.

Q84 — Correct Answer: A

On a constantcurrent (drooping VA characteristic) power source, the operating amperage is determined by the intersection of the drooping characteristic curve with the arc load line — this is governed by the arc length (which sets the arc voltage), not by the OCV setting. Increasing the OCV raises the Yintercept of the drooping curve (shifts the curve upward), which extends the range of arc lengths over which a stable arc can be maintained and makes initial arc striking easier. However, at any given stable arc length, the operating amperage changes only slightly because the drooping characteristic produces nearly constant current over a wide voltage range. B is wrong because OCV increase on a CC machine does not proportionally increase welding amperage through Ohm's law — the drooping characteristic is specifically designed to prevent this. C is wrong because changing OCV does not convert the machine from CC to CV characteristic. D is wrong because OCV does affect arc stability margin and maximum stable arc length even after arc establishment.

Q85 — Correct Answer: C

Zinc in galvanized coatings vaporizes at approximately 907°C, well below the welding temperatures of any arc process. This vaporization generates zinc oxide (ZnO) fumes that are an established cause of metal fume fever — an acute occupational illness. Additionally, liquid zinc entering the weld pool can penetrate austenite grain boundaries in lowcarbon steels through liquid metal embrittlement (LME), causing immediate intergranular HAZ cracking during the cooling cycle. Removal of the galvanized coating from the weld preparation area by grinding, wire brushing, or chemical stripping is required before welding begins. A is wrong because OFC to remove galvanizing generates zinc oxide fumes and does not produce a clean, weldable surface. B is wrong because no E7018 flux chemistry neutralizes zinc coating — this statement is false. D is wrong because zinc in the weld pool causes LME and fume hazards — it does not improve weld quality.

Q86 — Correct Answer: D

A visible notch at an inside weld corner creates a geometric stress concentration at the weld toe regardless of the applied load type. On a structural connection — even one that is statically loaded in its primary design function — reentrant corner notches at weld toes represent unacceptable weld quality under CSA W59. The notch must be repaired by depositing additional weld metal to fill the notch and blend the corner transition smoothly, eliminating the reentrant geometry. A is wrong because even for static loading, a visible notch at an inside corner is rejectable — the concern is not limited to cyclically loaded structures. B is wrong because documentation alone does not satisfy the repair requirement. C is wrong because no specific insidecorner notch tolerance of 0.8 mm for short weld lengths is provided in CSA W59.

Q87 — Correct Answer: B

A root gap that exceeds the WPS maximum constitutes a departure from a qualified welding procedure — effectively use of an unqualified procedure. The certified welder's professional obligation is to stop and report the nonconformance to the supervisor before any arc is struck. Either the joint must be corrected to bring the gap within the WPS limit, or formal engineering authorization must be obtained before welding an outoftolerance joint. A is wrong because "bridging" a nonconforming root gap with technique is not a universally accepted field practice — it constitutes welding outside the qualified parameter range, which is a certification violation. C is wrong because selfdocumenting a nonconformance in the traveller does not constitute authorization to weld outside the qualified WPS parameters. D is wrong because electrode manufacturers do not govern or approve deviations from welding code requirements for root gap tolerances.

Q88 — Correct Answer: C

Grade 91 (9Cr1MoV) steel derives its elevatedtemperature creep strength from a precipitationhardening mechanism involving vanadium carbides, niobium carbonitrides, and nitrides that precipitate in the martensitic microstructure during PWHT. To reproduce this creep mechanism in the deposited weld metal, the filler metal must contain vanadium, niobium, and nitrogen at the correct levels — the B9 filler metal designation specifically identifies this composition. E9015B9 and E9018B9 are the coderequired consumables for Grade 91 pressure piping welding. A is wrong because E9018B3 deposits 2.25Cr1Mo without the vanadium, niobium, and nitrogen additions that are essential for Grade 91 creep resistance. B is wrong because E8018B8 provides the 9Cr1Mo base chemistry but lacks the specific V, Nb, and N additions that define Grade 91's microstructural strengthening. D is wrong because E7018 carbon steel consumables are completely incompatible with Grade 91 service requirements.

Q89 — Correct Answer: A

Cold wind directly removes heat from the weld HAZ by convection at a rate that supplements the normal radiation and conduction cooling. The preheat requirement in the CSA W59 table is developed for stillair conditions. When wind creates additional convective cooling beyond the stillair assumption, the effective cooling rate through the martensite transformation range can exceed the threshold for cold cracking even while the measured preheat temperature is maintained. Erecting wind screens restores the intended stillair cooling rate for which the preheat was designed. B is wrong because increasing amperage changes the weld bead geometry and may introduce new quality problems — it is not a codeaccepted substitute for wind protection. C is wrong because no CSA W59 mandatory windspeedbased preheat increase table exists as described — wind screening is the established control. D is wrong because standard preheat table values do not incorporate a wind correction factor — wind protection is an additional separate requirement when wind is present.

Q90 — Correct Answer: D

The fundamental advantage of E71T5M over E71T1M for coldcrackingsensitive thicksection structural applications is its diffusible hydrogen performance. The T5 flux system uses a basic (lime/fluoride) slag chemistry analogous to the E7018 SMAW electrode family, producing diffusible hydrogen levels equivalent to H8 or better. The T1 wire uses a rutile flux that produces significantly higher diffusible hydrogen. When thick section and high restraint combine to create maximum cold cracking susceptibility, minimizing diffusible hydrogen is the critical selection criterion. A is wrong because T5 wire uses a basic slag system, not a rutile slag, and does not have inherently higher deposition rates than T1 at equivalent settings. B is wrong because E71T5M is a gasshielded wire requiring external CO_2 or Ar/CO_2 shielding gas. C is wrong because T5M and T1M produce fundamentally different diffusible hydrogen levels — this difference is the principal reason T5M is selected for cold crackingsensitive applications.

Q91 — Correct Answer: B

Cold laps in shortcircuit transfer GMAW result from insufficient heat at the weld toes between shortcircuit events. The pool has insufficient fluidity at the toes to wet out the base metal before the pool freezes at the next short circuit. Increasing voltage slightly within the upper end of the WPS range lengthens the arc between short circuits, delivers more thermal energy to the toe area before each short circuit occurs, and improves pool fluidity at the toes enough to promote fusion without disrupting the shortcircuit transfer mode. A is wrong because exceeding the WPS maximum WFS range is not a permitted production correction. C is wrong because standard 75/25 Ar/CO_2 is appropriate for structural shortcircuit GMAW, and reducing CO_2 to 5% would reduce penetration and create arc stability problems. D is wrong because a 6 mm CTWD is well below the normal operating range for GMAW and would cause feeding and burnback problems, not correct cold lap.

Q92 — Correct Answer: C

Spray transfer in GMAW requires the welding amperage to exceed a critical minimum threshold called the spray transition current. Below this current, gravitational and shortcircuit forces dominate over the electromagnetic pinch force, producing globular transfer. Above the transition current, the electromagnetic pinch force dominates and the wire transfers as a fine spray of droplets smaller than the electrode diameter. To transition from globular to spray, the wire feed speed must be increased to raise the amperage above this threshold. A is wrong because reducing wire feed speed lowers amperage further into the globular range. B is wrong because 75/25 Ar/CO_2 can support spray transfer on carbon steel — it requires higher transition current than highAr blends but spray is achievable. D is wrong because arc voltage affects arc length and stability but the primary triggering parameter for transfer mode transition is amperage, not voltage.

Q93 — Correct Answer: A

On a constantvoltage GMAW machine, the set voltage is maintained by the power source. When CTWD is increased, the longer electrode stub (the wire between the contact tip and the workpiece) undergoes greater resistive (I^2R) preheating. This preheating delivers energy to the wire before it reaches the arc, reducing the arc energy needed to complete melting. The CV machine compensates by slightly reducing the current from the power source while maintaining the set voltage, since the wire arrives partially preheated. This slight reduction in arc current combined with more efficient wire melting can modestly increase the deposition rate per unit of total arc current. B is wrong because CTWD increase does not proportionally extend arc length — the CV machine adjusts current to maintain the set voltage, not arc length. C is wrong because CTWD significantly affects electrical circuit characteristics and is not purely an ergonomic variable. D is wrong because increasing CTWD can increase or modestly improve deposition efficiency — it does not reduce deposition rate by 30%.

Q94 — Correct Answer: D

E71T8 is a selfshielded FCAW wire whose core ingredients generate protective gas compounds (including nitrogenexcluding CO and CO_2 from flux decomposition, plus deoxidizers) internally during the welding process. These internally generated shielding gases are not dependent on any external gas stream and are not disrupted by wind. Gasshielded processes (ER70S6 GMAW and E71T1M FCAWG) rely on an external gas stream that is physically dispersed by wind above approximately 8–10 km/h, making them unsuitable for unprotected outdoor use at 25 km/h. A is wrong because argon, despite being denser than air, is dispersed by 25 km/h wind and cannot provide adequate shielding outdoors at this speed. B is wrong because the flux core in T1M provides supplemental but not selfsufficient shielding — the external gas is still required and will be dispersed by wind. C is wrong because FCAWG wire in a windscreen does work, but the question specifically asks what can be used without windscreen protection.

Q95 — Correct Answer: B

Spray transfer produces a very large, highly fluid weld pool (due to high heat input) that requires precise positional control. In the flat position (1F), gravity assists pool control. In the horizontal position (2F), gravity pulls the large pool downward from the upper plate — creating metal overlap along the lower toe and convexity pulling away from the upper plate face. The standard solution is to convert to pulsed GMAW (pulsed spray), which delivers fusion energy in controlled bursts while allowing the pool to partially solidify between pulses, enabling horizontal fillet welding with acceptable geometry. A is wrong because the pool control challenges in 2F spray transfer are real and significant. C is wrong because increasing amperage in spray transfer worsens the pool control problem in the horizontal position. D is wrong because spray transfer is not absolutely prohibited in 2F — the standard solution is pulsed GMAW, not elimination of the process.

Q96 — Correct Answer: C

Metalcored wire consists of an outer metal tube filled with metallic powder. During welding, the arc melts both the outer tube and the core powder simultaneously, delivering more total deposited metal per unit of arc energy than a solid wire of the same nominal diameter. This produces higher deposition rates per amperehour — the primary production differentiator of metalcored wire versus solid wire. A is wrong because metalcored wire does not inherently require higher arc voltage than solid wire at equivalent settings. B is wrong because metalcored wire typically produces less spatter than solid wire in the spray and globular transfer modes due to better arc characteristics. D is wrong because metalcored wire is fully compatible with argonrich blends — high Ar/CO_2 and Ar/O_2 blends are standard for metalcored wire and are not a limitation.

Q97 — Correct Answer: A

In AWS A5.20, FCAW wire classification uses the second digit (the "0" in E70T1C versus the "1" in E71T1C) to communicate position capability. A "0" in that position indicates the wire is qualified only for flat and horizontal positions. A "1" indicates allposition capability. E70T1C has a "0" in the position digit, limiting it to flat and horizontal positions. The T1 rutile slag system produces a large, fluid slag pool that cannot be controlled in overhead or vertical positions — that is why T1 requires the allposition variant (E71T1C) to carry an additional positionmodification chemical package. B is wrong because the "C" suffix indicates shielding gas (100% CO_2), not position capability. C is wrong because position capability is directly encoded in the classification number — the "0" vs. "1" digit is the established communication. D is wrong because FCAW position limitations are not an amperageoverridable parameter — the wire must carry the correct classification for the required positions.

Q98 — Correct Answer: D

When weld metal porosity appears immediately after changing to a new shielding gas cylinder despite all other parameters remaining unchanged, moisture contamination of the new cylinder is the most probable cause. Water vapor in the shielding gas dissociates in the arc and introduces hydrogen into the weld pool, producing hydrogen porosity upon solidification. Contaminated cylinders can result from improper purging during filling, damaged valve seat seals, or noncompliant cylinder filling procedures. The cylinder should be returned to the supplier. A is wrong because Ar/CO_2 blends do not fractionate inside the cylinder — the gases remain uniformly mixed under pressure. B is wrong because the minimum required flow rate does not vary significantly between production batches of the same gas blend specification. C is wrong because while air contamination during filling is possible, moisture contamination is the more common cause of this specific pattern changing suddenly with a new cylinder.

Q99 — Correct Answer: B

Interpass slag inclusions in FCAWG multipass welds result from slag that is not completely removed between passes. When the next pass is deposited, incompletely removed slag is remelted into the pool and becomes trapped at the fusion boundary when the pool solidifies. The direct and complete solution is to chip and wire brush all slag thoroughly between every pass, inspect the prepared surface visually for any remaining slag bridges or lockedin material, and confirm complete removal before depositing the next pass. A is wrong because switching to verticaldown changes the travel direction but does not eliminate interpass slag inclusion if cleaning is not performed. C is wrong because exceeding the WPS maximum WFS is not accepted as a slagmelting correction and may introduce other defects. D is wrong because backstep technique addresses the solidification front progression, not the slag removal obligation.

Q100 — Correct Answer: C

The described pattern — smooth feed for several minutes, brief complete stop with arc extinction, then resumption — at irregular intervals is characteristic of a kink or misaligned wire coil at the wire spool periodically catching on the spool flange. As the spool rotates to pay out wire, the misaligned coil intermittently catches and momentarily blocks feed. When the mechanical resistance overcomes the catch, the wire releases and feed resumes normally. The spool must be inspected for wire tangles or coil misalignment and the backtension brake adjusted. A is wrong because GMAW power sources do not automatically command wire feed suspension based on shielding gas pressure monitoring. B is wrong because an undersized contact tip would cause persistent, not intermittent, feeding difficulty. D is wrong because inadequate workpiece grounding causes arc voltage instability and spatter, not clean stopandresume wire feeding cycles.

Q101 — Correct Answer: D

During GTAW of aluminum, when the arc is extinguished, the molten aluminum pool surface oxidizes rapidly in the brief interval before postflow shielding gas fully protects the cooling pool. When the arc is restarted, this surface oxide is mechanically pushed into the weld pool by the arc pressure and pool movement and becomes incorporated into the solidifying deposit as dark oxide inclusions. Prevention requires ending the arc on a runoff tab, using a controlled slopedown to a fullyfilled crater before extinction, or restarting on alreadysolidified weld metal to avoid disturbing a surfaceoxidized pool. A is wrong because DCEP postpurge is not a recognized GTAW arcstop procedure for aluminum. B is wrong because the marks result from oxide folded in at the stop location, not from failed cathodic cleaning of the base metal surface at the restart. C is wrong because the marks are metallurgical contamination (oxide inclusions) requiring technique correction — they are not a cosmetic artifact without structural significance.

Q102 — Correct Answer: A

Under DCEP (electrode positive), the electrode is the anode and the base metal is the cathode. Approximately twothirds of the arc energy concentrates at the anode (electrode), causing the tungsten to heat significantly and form the characteristic ball — this is the expected and accepted behavior of DCEP GTAW. The key metallurgical benefit is intense, continuous cathodic cleaning: the electron bombardment traveling from the base metal surface (cathode) to the electrode (anode) physically disrupts and removes the aluminum oxide layer throughout the welding period. The shallow penetration and large balled electrode are the expected and accepted tradeoffs for this oxidecleaning technique application. B is wrong because DCEP tungsten balling is expected behavior and is not corrected by a larger electrode — it is an inherent characteristic of DCEP on aluminum. C is wrong because EWP electrodes can be used on DCEP — the balling is not a polarity compatibility failure. D is wrong because DCEP concentrates energy at the electrode (anode), not at the base metal — shallow penetration results precisely because less energy goes to the base metal on DCEP.

Q103 — Correct Answer: B

The WPS specifies that welding cannot begin until the oxygen level is confirmed below 1,000 ppm. With the current reading at 1,500 ppm after 20 minutes, the specification has not been met. The correct action is to continue purging with argon at the same flow rate and wait for the analyzer to confirm the level has reached or dropped below 1,000 ppm. Additional purge time will continue displacing residual oxygen from the pipe interior. A is wrong because beginning welding at 1,500 ppm is a direct violation of the WPS parameter. C is wrong because forcepressurizing a backpurged pipe spool is not a recognized or safe technique for oxygen level reduction. D is wrong because the downstream vent reading is actually the most conservative (worstcase) reading during purging — oxygen tends to clear last at the vent location, so the weld zone is not necessarily better than the downstream reading at this stage of purging.

Q104 — Correct Answer: C

Sharing tools, tungsten electrodes, and filler rod holders between carbon steel and 304L stainless steel welding transfers carbon steel iron particles and contamination to the stainless steel weld zone. Iron pickup in the stainless deposit reduces local chromium concentration (dilution effect), and carbon contamination can accelerate sensitization in the HAZ. Dedicated stainless steel tools and consumables that are never contacted by carbon steel must be maintained in isolation to prevent this crosscontamination. A is wrong because carbon steel residue does not increase thermionic emission to the degree that affects arc width specification compliance. B is wrong because while iron pickup is the specific mechanism, option C more completely captures the full scope of the crosscontamination concern. D is wrong because contamination absolutely affects stainless steel weld quality — the claim that arc temperature vaporizes all contaminants is false and dangerous.

Q105 — Correct Answer: D

A concave root bead in autogenous GTAW pipe welding results from the arc advancing along the joint faster than sufficient molten metal can pool at the root to fill the preparation to a flat or slightly convex profile. Reducing travel speed allows more heat and time for the weld pool to build up at the root. Increasing amperage adds more heat energy to melt more base metal and fill the root gap. Either or both corrections address the root cause: insufficient pool volume at the root per unit length of travel. A is wrong because excessive arc voltage (long arc) increases bead width and reduces penetration concentration but does not primarily cause concave root bead in the manner described. B is wrong because autogenous GTAW root beads can and should be flat or slightly convex — concave profile is not codeacceptable for most pressure piping applications. C is wrong because back purge flow rate affects oxidation protection color, not root fill profile.

Q106 — Correct Answer: A

A gas lens replaces the standard collet body with a porous screen or stacked mesh disc that transforms the turbulent, highvelocity shielding gas flow inside the torch into a laminar (uniform, parallelstreamline) flow around the electrode and arc zone. This laminar flow provides several advantages: more uniform atmospheric exclusion over a wider area below the nozzle, the ability to extend the electrode further from the nozzle without losing shielding effectiveness (which improves visibility and access), and reduced turbulence that could otherwise draw atmospheric air into the shielding zone and contaminate the tungsten electrode. B is wrong because gas pressure reduction is a secondary effect — the primary benefit is flow quality transformation from turbulent to laminar. C is wrong because a gas lens improves flow quality, not necessarily overall flow rate. D is wrong because gas lenses do not contain copper mesh static electricity filters — this mechanism is not part of gas lens function.

Q107 — Correct Answer: C

For GTAW pipe root passes, the filler rod diameter should approximate the root gap dimension to allow precise incremental metal additions. A 2.4 mm rod for 4inch Schedule 40 pipe provides the controlled, incrementally deposited metal additions needed for managing root pass keyhole fill and reinforcement height precisely with each dip. Selecting a smaller rod gives the welder maximum control over the pool volume added with each addition. A is wrong because the selection guideline for GTAW filler rod is not "exceed the pipe wall thickness." B is wrong because filler rod diameter is selected based on root pass geometry requirements, independently from the tungsten electrode diameter. D is wrong because filler rod diameter significantly affects deposition control technique — claiming it has no practical effect misrepresents the process fundamentals.

Q108 — Correct Answer: B

Between GTAW passes on austenitic stainless steel, the weld face oxidizes rapidly in air and forms a surface oxide film — ranging from gold/straw (light oxidation) to blue or darker (heavier oxidation). Even a light oxide film must be completely removed by stainless steel wire brushing before depositing the next pass. Any remaining oxide is melted into the new weld pool, and when the pool solidifies, the oxide becomes trapped as a dark inclusion particle visible on the weld face after grinding. A is wrong because tungsten erosion inclusions from arc initiation are prevented by HF arc starting and good technique — they are a separate concern from the interpass cleaning issue described. C is wrong because silicon residue from ER316L is relevant to carbon steel grinding but the primary issue for multipass stainless is the interpass oxidation layer. D is wrong because lead contamination from solvents is an extreme and unrelated scenario.

Q109 — Correct Answer: D

Titanium is highly reactive with atmospheric oxygen and nitrogen above approximately 400°C. The blue discoloration confirms that the hot weld metal surface was exposed to atmosphere before cooling below the reaction threshold. The shielding coverage area is insufficient — either the trailing gas shield is too short to cover the cooling weld behind the arc, the postflow time is too short to protect the pool until it solidifies and cools below 400°C, or the gas shoe geometry is inadequate. The corrective action is to extend the trailing shield coverage and/or increase postflow time to maintain inert atmosphere over the complete hot metal zone. A is wrong because tungsten oxide from a cold start would affect the weld metal rather than produce the longitudinal color pattern described. B is wrong because electrode size instability would produce erratic arc behavior throughout the weld, not the described heatdependent oxidation pattern. C is wrong because uniform gas purity deficiency would affect the entire weld consistently — the variable silvertoblue pattern is more indicative of inadequate coverage area than uniform purity failure.

Q110 — Correct Answer: A

Pulsed DC GTAW alternates between a highenergy peak phase (140 A) that delivers the fusion energy for penetration and a lowenergy background phase (40 A) that allows the pool to partially cool and solidify between pulses. The peak current provides the necessary penetration through the 3 mm wall, while the background phase reduces the average heat input significantly compared to continuous 140 A welding. This controlled heat delivery reduces distortion and HAZ width on thinwall pipe — a critical advantage for stainless steel pipe that must meet tight distortion and metallurgical requirements. B is wrong because back purging is still required for stainless steel root pass protection regardless of the GTAW power mode. C is wrong because pulsed GTAW does not reduce diffusible hydrogen — GTAW inherently produces very low hydrogen and the pulsing does not change this. D is wrong because pulsed DC GTAW is fully compatible with manual torches and is widely used in manual and semiautomatic pipe welding.

Q111 — Correct Answer: C

ER5356 is an AlMg (magnesiumalloyed) filler wire that closely matches the alloying base of 5083H321 aluminum (which is also an AlMg alloy). When anodized, ER5356 deposits produce a cosmetically similar color response to the anodized 5083 base metal because the Mg content of both materials interacts with the anodizing bath in a comparable way. ER4043, by contrast, contains approximately 5% silicon, and siliconrich aluminum reacts distinctly differently with the anodizing bath — producing a dark, gray or black deposit that is cosmetically unacceptable adjacent to the lighteranodizing 5083 base metal. A is wrong because ER4043 produces poor cosmetic anodizing results on 5083 — the silicon content creates the dark appearance. B is wrong because ER1100 pure aluminum does not provide the matching color response or the mechanical properties required for 5083 weld joints. D is wrong because ER5554 is also acceptable for 5083 but ER5356 is the standard industry answer for anodizing applications on 5083 base metal.

Q112 — Correct Answer: B

During AC GTAW aluminum welding at 200 A, the EWP electrode tip forms a ball of molten or semimolten tungsten. At 200 A with a 3.2 mm electrode, this ball can grow to 5–6 mm in diameter — larger than the electrode diameter itself. The ball's outer surface is physically further from the original electrode tip position by the ball's radius, effectively adding several millimetres to the electrodetowork gap even when the ball surface appears reasonably close to the work. Using a 4.0 mm EWP electrode supports a larger ball within a normalsize range for the current, reducing the apparent arc extension. A is wrong because reducing electrode size would worsen the balling problem at 200 A on a 2.4 mm electrode — 3.2 mm is already marginal, not oversized. C is wrong because nitrogen contamination would affect arc column consistency across all positions, not specifically create a uniform arc extension pattern. D is wrong because gas flow turbulence causing arc extension is not a recognized mechanism for the described symptom.

Q113 — Correct Answer: D

The 30 L/min purge flow rate creates turbulent argon flow inside the 168.3 mm ID, 3metre pipe spool. At this elevated flow rate, the highvelocity argon stream exits the downstream vent as a turbulent jet that creates negative pressure zones inside the pipe — these zones draw ambient air back into the pipe from the downstream vent opening as the jet induces entrainment. This air reentrainment creates pockets of residual oxygen even after the sensor shows an overall low reading. Reducing to 6–8 L/min produces laminar, stratified flow that uniformly displaces oxygen from bottom to top without creating the turbulent entrainment that causes the inconsistent oxygen distribution. A is wrong because variable travel speed would affect heat input patterns but would not create the atmospheric contamination producing titaniumlike oxidation color variation. B is wrong because the density differential argument would affect the sensor reading at the vented top of the pipe, producing consistent variation by clock position — not the random variation along weld length described. C is wrong because 30 L/min is actually a high flow rate for this pipe geometry — the issue is flow regime, not inadequate purge volume.

Q114 — Correct Answer: A

When SAW flux passes through the arc zone, it undergoes thermal decomposition that produces fine particle fragments (fines), incorporates slag chips from the solidified slag layer, and absorbs moisture in the transition from molten to solid state in the heataffected zone around the weld. Returning this unprocessed material directly to the flux hopper introduces these fines and contaminants into the flux blend. Fines increase the gas generation rate (causing porosity) and alter the flux chemistry toward a composition different from the qualified procedure. The proper protocol is screening to remove fines and slag chips, drying to the manufacturer's specification, and blending with a defined proportion of fresh flux before reuse. B is wrong because iron and manganese contamination from the weld pool is possible but the primary quality concern from unprocessed recycling is the fines and moisture content. C is wrong because SAW flux recycling is a standard and economically necessary practice — it must be properly processed, not abandoned entirely. D is wrong because static electricity is not the mechanism responsible for the described porosity and impact test failures.

Q115 — Correct Answer: C

A depthtowidth ratio above 1.0 means the weld bead is deeper than it is wide — a narrow, deep bead profile. This geometry concentrates the solidification contraction stresses (which act perpendicular to the solidification front) along the narrow weld centreline, and allows lowmelting impurityrich liquid (MnS, P compounds) to segregate and concentrate at the centre of the solidification front throughout the full depth of the bead. The combination of concentrated impurities and high centreline tensile stress creates a highly susceptible condition for solidification (hot) cracking at the weld centreline. The correction is to reduce D/W by widening the bead through reduced amperage, increased travel speed, or increased arc voltage. A is wrong because D/W ratio refers to the bead crosssection geometry, not the relationship between bead width and groove preparation width. B is wrong because D/W ratio does not affect corrosion resistance by the mechanism described. D is wrong because flux coverage depth is not the primary controlling parameter for D/W ratio — it is governed by arc energy balance parameters.

Q116 — Correct Answer: B

Active SAW flux interacts with the arc and adds manganese and silicon to the deposited weld metal above the wire's base chemistry through thermochemical reactions in the arc zone. Neutral flux maintains the deposit composition close to that of the wire. This means substituting an active flux for a specified neutral flux changes the deposited weld metal composition — potentially increasing Mn and Si above the ANumber range qualified in the WPS. Under ASME Section IX, a change in the ANumber of the deposited weld metal is an essential variable requiring PQR requalification. A is wrong because the active/neutral distinction does not relate to organic binder content or hydrogen generation in the way described. C is wrong because active flux melting temperature relative to neutral flux is not the code concern for this substitution. D is wrong because active and neutral designations absolutely refer to the chemical reactivity of the flux with the arc — not particle size — and do produce different deposit compositions.

Q117 — Correct Answer: D

Tandem SAW uses two wire electrodes in the same molten pool simultaneously (commonly lead DCEP and trail AC configuration), achieving deposition rates that typically double or exceed those of singlewire SAW. For a 30 kg groove requiring many passes at singlewire rates, tandem SAW dramatically reduces the number of passes and arcon time required, significantly shortening the total production cycle for each vessel shell seam and reducing the cost per unit. A is wrong because both singlewire and tandem SAW are limited to flat and horizontal positions — tandem SAW does not enable outofposition operation. B is wrong because tandem SAW requires dedicated operator supervision and does not halve labor requirements. C is wrong because flux consumption per kilogram of weld metal deposited is not inherently halved by the tandem configuration — the overall consumable volume changes proportionally to the deposit.

Q118 — Correct Answer: A

In the AWS A5.17 SAW flux classification system, the digit after the condition letter "A" (aswelded) in the designation indicates the minimum Charpy Vnotch test temperature: the digit multiplied by −10°F gives the test temperature. F7A4 = tested at 4 × (−10°F) = −40°F. F7A2 = tested at 2 × (−10°F) = −20°F. The specification requires −40°F impact performance, so only Brand A (F7A4) is confirmed to meet this requirement. Brand B (F7A2) was tested at −20°F and is not demonstrated to meet the −40°F requirement. B is wrong because F7A2 and F7A4 are not equivalent — they were tested at different temperatures and one may not meet the other's requirement. C is wrong because a higher digit in the Anumber designation means a colder test temperature — F7A4 is more demanding than F7A2, not less. D is wrong because both flux brands use the compatible EM12K wire designation and the classification system does not require identical manufacturer identification for substitutability.

Q119 — Correct Answer: C

SAW parameters qualified and optimized for 25 mm plate apply heat input, amperage, and travel speed appropriate for that plate's thermal mass and penetration requirements. When applied to 8 mm plate, the same parameters deliver a disproportionate heat input relative to the thin plate crosssection — causing burnthrough, excessive meltthrough, warping, and severe thermal distortion. The parameters must be substantially reduced (lower amperage, higher travel speed, reduced voltage) to provide a heat input level appropriate for the thin plate application. A is wrong because incomplete fusion from excessive travel speed is a thickplate concern — on thin plate the problem is too much heat input, not too little. B is wrong because plate thickness has a major effect on required parameters — the fillet size specification alone does not govern SAW parameters for thinplate applications. D is wrong because the burnthrough and distortion problems occur first and are far more severe than any slag inclusion issues that might also develop.

Q120 — Correct Answer: B

The initial arc strike at the start of a circumferential SAW seam creates a crater area that characteristically contains porosity, solidification (crater) cracks, and slag inclusions from the arc initiation conditions. When the final weld revolution overlaps this starting point by approximately 25 mm, this defective start zone is covered by sound weld metal but remains embedded in the joint. The weld start zone within the overlap area must be excavated to remove all defects, verified by NDE to confirm complete removal, and if defects are found, repaired before the final seam is accepted. A is wrong because while excess reinforcement at the overlap is a real concern, grinding the cap height is a straightforward operation — the embedded crater defects are the more serious concern. C is wrong because mandatory RT of the overlap region specifically is not a universal code requirement independent of the NDE plan for the rest of the seam. D is wrong because doubletemperature PWHT for the overlap zone is not required or recognized under ASME VIII Division 1.

Q121 — Correct Answer: D

Tandem SAW deposits from two electrodes simultaneously in the same molten pool, commonly in a lead DCEP plus trail AC configuration. The combined deposition rate often exceeds double that of singlewire SAW. For a demanding application requiring 30 kg of weld metal per 300 mm seam on 75 mm wall vessels with multiple such vessels in the production run, this dramatic reduction in passes, arcon time, and interpass temperature management cycles translates directly to substantial production time and cost reduction. A is wrong because tandem SAW is limited to flat and horizontal positions just as singlewire SAW is. B is wrong because tandem SAW systems require continuous dedicated operator monitoring. C is wrong because flux consumption does not inherently halve per kilogram of deposit with tandem SAW.

Q122 — Correct Answer: A

The maximum heat input limit in a SAW impacttested procedure controls the coarsegrained HAZ (CGHAZ) grain size. Higher heat input increases the time the HAZ spends above the graincoarsening temperature (approximately 1,100°C), allowing prior austenite grains to grow to larger sizes. Larger CGHAZ grains have less total grain boundary area per unit volume, which reduces the energy available for arrest of crack propagation during impact testing — directly reducing Charpy toughness below the values achieved during PQR qualification at the qualified maximum heat input. B is wrong because carbon content is fixed by the base metal specification and does not increase through weld metal diffusion during a SAW pass. C is wrong because heat input does not create significant permanent magnetization in structural steel. D is wrong because the HAZ in structural carbon steel does not permanently transform to austenite at these heat input levels.

Q123 — Correct Answer: B

E7018 electrodes exposed to atmospheric moisture before use absorb water into the basic coating, significantly elevating diffusible hydrogen in the deposit above the Hclass limit. Hydrogen stored in the tack weld metal at concentrations well above normal is stable until the SAW arc remelts the tack. During rapid remelting by the SAW arc (which reaches the tack in milliseconds), the suddenly very hot tack metal rapidly liberates stored hydrogen. The hydrogen exits through the molten SAW pool surface as discrete bubbles, producing the characteristic porosity cluster directly above each tack weld location. A is wrong because residual magnetism from tack welding can cause arc blow but would affect the weld globally, not specifically at each tack location. C is wrong because slag from E7018 tacks must be removed before SAW regardless, and if properly removed, it would not cause localized chemistry incompatibility at each tack. D is wrong because tack weld profile height causing reduced flux coverage would produce coveragerelated issues uniformly where coverage is reduced, not the specific porosity cluster pattern described.

Q124 — Correct Answer: C

ASME Section IX QW175 and QW200 require that when impact testing is designated, Charpy Vnotch specimens must be extracted from both the weld metal and the heataffected zone of the PQR test coupon. Weld metal specimens independently verify the SAW deposit's impact toughness at the specified test temperature. HAZ specimens independently verify that the base metal was not embrittled by the SAW thermal cycle. Both zones must separately meet the minimum impact energy requirement — passing one zone alone is not sufficient. A is wrong because extracting specimens only from the weld centerline is not the complete ASME IX requirement when impact testing is specified. B is wrong because testing only the HAZ neglects the weld metal, which must also be independently qualified. D is wrong because no singlepass/multipass distinction changes the requirement for both weld metal and HAZ testing under ASME IX impacttested procedures.

Q125 — Correct Answer: D

The transverse centreline cracks in thicksection SAW using highMn, highSi active flux wire are the classic signature of solidification (hot) cracking. The active flux contributes additional Mn and Si to the deposit beyond the wire's base chemistry, raising the deposit's concentration of elements that lower the solidus temperature and expand the solidification temperature range. Combined with a D/W ratio exceeding the recommended maximum (deep, narrow bead), the solidification mechanics create a deep narrow centreline where lowmelting impurityrich liquid concentrates throughout the full bead depth. The solidification contraction forces acting perpendicular to the centreline pull this lasttosolidify liquid zone apart, producing transverse hot cracks at the centreline of each affected pass. A is wrong because lackoffusion produces planar defect indications at fusion boundaries, not transverse centreline cracking in the weld metal. B is wrong because hydrogeninduced cold cracking characteristically produces longitudinal HAZ cracks or underbead cracks after the weld cools — not transverse centreline cracks in the weld metal during solidification. C is wrong because slag inclusion breakdown products from active flux produce slagtype inclusions detectable by UT and RT — they do not fracture as transverse centreline cracks.