PRACTICE EXAM 9: ABC CLASS I WASTEWATER TREATMENT SIMULATION (100 QUESTIONS)

1. A treatment plant operator reviews the plant's monthly influent data summary and notices that the ratio of BOD to TSS has changed from the normal 0.85 (e.g., BOD 200/TSS 235) to 1.4 (e.g., BOD 280/TSS 200) over the past six weeks. The total flow has not changed. What does this shift in the BOD/TSS ratio most likely indicate?

A. The collection system has developed a significant blockage that is holding back settleable solids

B. A new industrial or commercial source is contributing high-strength dissolved organic waste with relatively low suspended solids content

C. The primary clarifier has improved its performance and is removing more TSS before the influent sample point

D. The influent sample location has shifted to a point downstream of the primary clarifier

2. An operator at a plant serving a coastal community notices that during very high tides, the influent conductivity increases from 900 µS/cm to 3,200 µS/cm and the chloride concentration doubles. The flow increases slightly but all other wastewater parameters remain normal. What is the most likely cause?

A. The coastal community increases water use during high tides, flushing more dissolved minerals into the sewer

B. The high tide backs up the plant outfall, causing saltwater to re-enter the plant through the effluent line

C. The tidal fluctuations cause changes in the groundwater chemistry near the treatment plant

D. Saltwater is infiltrating into the collection system through tidally influenced pipes, manholes, or outfall connections during high-tide events

3. An operator measures the influent temperature at 55°F (13°C) in November. The same operator measured the influent temperature at 72°F (22°C) in August. What operational parameter will the operator most likely need to adjust for winter operations to maintain nitrification?

A. The chlorine dose must be doubled during winter because cold water reduces chlorine's disinfection effectiveness

B. The RAS rate should be reduced by 50% because cold-weather settling is more efficient and requires less return sludge

C. The SRT must be extended by reducing the WAS rate because nitrifying bacteria grow more slowly at colder temperatures

D. The aeration rate should be reduced because cold water holds more dissolved oxygen than warm water

4. An operator collects an influent sample and measures a dissolved oxygen concentration of 0.2 mg/L. The wastewater has a strong hydrogen sulfide odor. The collection system includes a 3-mile force main from an upstream pump station with a 6-hour travel time. What condition does this sample indicate about the force main?

A. The wastewater has become septic during the long detention time in the force main, depleting all dissolved oxygen and creating conditions for sulfate-reducing bacteria to produce H_2S

B. The upstream pump station is injecting too much air into the force main, causing the wastewater to become supersaturated with oxygen

C. The force main is made of concrete, which naturally neutralizes the hydrogen sulfide before it reaches the plant

D. The dissolved oxygen reading of 0.2 mg/L indicates the wastewater is well-aerated from the pumping action

5. A treatment plant accepts hauled waste at a receiving station. The operator receives a tanker of waste from a portable toilet servicing company. The manifest indicates the waste is "portable toilet waste." The operator tests the waste and measures: pH 8.8, ammonia nitrogen 350 mg/L, BOD 5,500 mg/L, and a strong blue-green color with a formaldehyde odor. Which of the following is the primary concern with accepting this waste?

A. The high ammonia will cause immediate nitrification failure in the aeration basin

B. The formaldehyde biocide used in portable toilets is toxic to the biological treatment organisms and must be discharged at a controlled rate to avoid inhibiting the biology

C. The blue-green dye will discolor the plant effluent and cause a visible permit violation

D. The pH of 8.8 exceeds the maximum allowable pH for influent discharges to the plant

6. An activated sludge plant operator observes the following simultaneous conditions: the effluent BOD has increased from 10 to 28 mg/L, the effluent TSS has increased from 8 to 35 mg/L, the aeration basin DO has dropped from 2.5 to 0.8 mg/L, the MLSS has increased from 2,800 to 3,600 mg/L, and the SVI has increased from 110 to 195 mL/g. The influent BOD has not changed. What single root cause most likely explains ALL of these simultaneous symptoms?

A. A toxic discharge has killed the biological organisms and the dead cells are increasing the TSS

B. The primary clarifier has failed, sending excessive organic load to the aeration basin

C. The secondary clarifier center well has developed a crack that is bypassing flow around the settling zone

D. The WAS pump has failed — solids are accumulating (higher MLSS), oxygen demand is increasing (lower DO), settling is deteriorating (higher SVI), and solids are washing over the clarifier weir (higher effluent TSS and BOD)

7. An operator at a plant with both nitrification and denitrification reviews the following monthly average data: effluent ammonia 0.3 mg/L, effluent nitrate 2.1 mg/L, effluent organic nitrogen 1.2 mg/L, and effluent total nitrogen 3.6 mg/L. The permit limit for total nitrogen is 8.0 mg/L. The operator calculates that the plant has significant margin below the limit. Which of the following represents the greatest risk to maintaining this excellent performance?

A. A sustained cold-weather period that reduces the nitrification rate, causing ammonia to rise and total nitrogen to increase

B. An increase in the influent flow that reduces the hydraulic detention time in the aeration basin

C. A decrease in the influent BOD that reduces the available carbon source for denitrification in the anoxic zone

D. An increase in the RAS rate that disrupts the internal recycle ratio and changes the anoxic zone performance

8. A plant operates a circular primary clarifier with a diameter of 65 feet and a sidewater depth of 12 feet. The influent flow is 2.5 MGD. The operator calculates the surface overflow rate and detention time. Which of the following pairs of values is approximately correct?

A. SOR of 550 GPD/ft² and DT of 3.5 hours, both indicating severe hydraulic underloading

B. SOR of 754 GPD/ft² and DT of 2.5 hours, both within the typical design range for primary clarifiers

C. SOR of 754 GPD/ft² and DT of 2.4 hours, both within the typical design ranges

D. SOR of 1,200 GPD/ft² and DT of 1.2 hours, indicating hydraulic overloading at the current flow

9. An activated sludge system has the following parameters: MLSS 3,000 mg/L, MLVSS 2,400 mg/L, aeration basin volume 0.9 MG, plant flow 3.6 MGD, and primary effluent BOD 150 mg/L. The operator calculates the F/M ratio using MLVSS. What is the F/M ratio, and what does it indicate about the system operation?

A. F/M is 0.10, indicating the system is in the extended aeration range with risk of pin floc formation

B. F/M is 0.15, indicating the system is at the boundary between conventional and extended aeration

C. F/M is 0.25, indicating the system is operating in the mid-range of conventional activated sludge

D. F/M is 0.35, indicating the system is operating at the high end of conventional activated sludge

10. An operator at a treatment plant with biological nutrient removal measures the following ORP (oxidation-reduction potential) readings in the process zones: anaerobic zone –250 mV, anoxic zone –100 mV, aerobic zone +150 mV. Which of the following is the correct interpretation of these ORP values?

A. The ORP readings are reversed — the anaerobic zone should have the highest positive ORP value

B. The ORP profile confirms proper zone conditions: the anaerobic zone is truly anaerobic (strongly negative), the anoxic zone is moderately reduced (mildly negative), and the aerobic zone is oxidized (positive)

C. The anoxic zone ORP of –100 mV indicates that dissolved oxygen is present and denitrification cannot occur

D. All three zones need adjustment because the ORP values should be identical throughout the BNR system

11. A treatment plant operates a chlorine contact tank with a measured theoretical detention time of 30 minutes. The baffling factor (ratio of T_{10} to theoretical detention time) is 0.5 due to significant short-circuiting. The measured chlorine residual at the outlet is 1.5 mg/L. What is the effective CT value that the regulatory agency will use for compliance?

A. CT = 1.5 × 15 = 22.5 mg·min/L, using the T_{10} of 15 minutes (30 × 0.5) multiplied by the outlet residual

B. CT = 1.5 × 30 = 45 mg·min/L, using the full theoretical detention time multiplied by the outlet residual

C. CT = 3.0 × 15 = 45 mg·min/L, using double the outlet residual to account for the short-circuiting factor

D. CT = 1.5 × 7.5 = 11.25 mg·min/L, using 25% of the theoretical detention time as the effective contact period

12. An operator at a nitrifying activated sludge plant discovers that the effluent nitrite (NO_2^-) concentration has increased from the normal trace level (0.1 mg/L) to 4.5 mg/L while the effluent ammonia remains low at 0.8 mg/L. The effluent nitrate has decreased from 22 mg/L to 16 mg/L. What does this elevated nitrite level indicate?

A. The first-stage nitrifiers (Nitrosomonas) are functioning normally but the plant is producing excessive ammonia

B. The denitrification process is reducing nitrate to nitrite as an intermediate step before converting to nitrogen gas

C. The pH has dropped below the optimal range and is inhibiting both stages of nitrification equally

D. The second-stage nitrifiers (Nitrobacter) are being selectively inhibited while the first-stage Nitrosomonas continue converting ammonia to nitrite — nitrite is accumulating because it is not being converted to nitrate

13. A treatment plant with two parallel activated sludge trains reports the following data: Train A — MLSS 2,500, SVI 108, effluent BOD 9, effluent TSS 7. Train B — MLSS 2,500, SVI 108, effluent BOD 9, effluent TSS 28. Both trains receive equal flow and the same primary effluent. The secondary clarifiers are identical. What is the most likely cause of Train B's elevated effluent TSS despite identical biological parameters?

A. Train B's aeration system is producing different bubble sizes that affect floc formation

B. Train B's MLVSS/MLSS ratio is lower than Train A's, indicating more inert solids that settle poorly

C. Train B's WAS rate is higher than Train A's, causing a shorter SRT and weaker floc formation

D. Train B's secondary clarifier has a physical defect — damaged weir, misaligned launder, or worn center well — that is allowing solids to escape despite good biological settling

14. A treatment plant uses sodium hypochlorite for disinfection and sulfur dioxide for dechlorination. The effluent fecal coliform is consistently below 50 CFU/100 mL, well below the permit limit of 200. However, the effluent total residual chlorine frequently exceeds the 0.019 mg/L TRC limit. What is the most likely cause of the TRC exceedance?

A. The dechlorination system is underdosed — the sulfur dioxide feed rate is insufficient to neutralize all of the chlorine residual leaving the contact tank

B. The chlorine contact time is too long, causing the chlorine to convert to a form that sulfur dioxide cannot neutralize

C. The effluent pH is too high for effective dechlorination, reducing the reaction rate between SO_2 and chlorine

D. The TRC analyzer is malfunctioning and providing false high readings that do not reflect the actual chlorine level

15. A plant operator calculates the following: the aeration basin has an MLSS of 3,200 mg/L and a volume of 0.75 MG. The system contains 20,016 lbs of MLSS. The WAS rate is 0.025 MGD at a WAS concentration of 9,500 mg/L. The effluent TSS is 12 mg/L at 2.5 MGD. What is the SRT?

A. SRT is approximately 4.2 days, which is in the high-rate range and insufficient for nitrification

B. SRT is approximately 8.0 days, which is in the conventional range and adequate for nitrification at moderate temperatures

C. SRT is approximately 12 days, which provides comfortable margin for nitrification at cold temperatures

D. SRT is approximately 16 days, which places the system in the extended aeration range

16. An activated sludge plant operator takes over for a retiring colleague and reviews the plant's operating history. The previous operator maintained an MLSS of 4,500 mg/L and an SRT of 22 days, producing excellent effluent quality (BOD 5, TSS 4, NH_3 0.3). However, the energy costs for aeration are 40% higher than comparable plants. The new operator wants to reduce energy costs while maintaining compliance. Which adjustment is most appropriate?

A. Reduce the MLSS and SRT to conventional levels, which will maintain treatment quality while reducing the oxygen demand and energy consumption

B. Install variable frequency drives on the blowers to modulate airflow based on demand rather than running at constant speed

C. Gradually reduce the MLSS to approximately 2,500-3,000 mg/L by increasing the WAS rate, which will reduce the oxygen demand while verifying that effluent quality remains in compliance at each step

D. Shut down one of the two aeration basins to reduce the total volume requiring aeration

17. A treatment plant effluent has a consistently low UV transmittance of 50% despite an effluent TSS of only 8 mg/L. The UV system struggles to deliver the required dose. The operator suspects that

dissolved organic compounds are absorbing UV light. Which of the following influent characteristics would most likely contribute to low UV transmittance independent of TSS?

A. High influent alkalinity from a limestone aquifer supplying the community's drinking water

B. High influent ammonia from a community with septic-to-sewer conversions

C. High influent chloride from a water softener regeneration brine discharge by a large industrial user

D. High influent color or dissolved organic compounds from tannin-rich industrial discharges or natural organic matter in the water supply

18. An operator at a conventional activated sludge plant calculates that the secondary clarifier solids loading rate is 35 lbs/day/ft² — above the typical maximum of 30 lbs/day/ft². The effluent TSS is currently acceptable at 12 mg/L, but the operator is concerned about marginal performance during peak flows. Which of the following is the most effective short-term corrective action?

A. Increase the aeration basin DO to reduce the oxygen demand in the secondary clarifier

B. Reduce the MLSS by increasing the WAS rate, which decreases the mass of solids entering the clarifier

C. Increase the weir length by installing additional effluent launders in the secondary clarifier

D. Reduce the RAS rate to decrease the total flow volume entering the clarifier

19. An operator at a plant with UV disinfection reviews the UV system maintenance log and discovers that the quartz sleeve cleaning system has been non-functional for 45 days. The UV intensity readings from the sensors behind the sleeves show a gradual decline of 15% from baseline. The effluent fecal coliform remains below the permit limit. Despite the current compliance, what should the operator do?

A. Repair the cleaning system immediately because the declining intensity indicates progressive fouling that will eventually cause a fecal coliform exceedance if not corrected

B. Wait until the fecal coliform results exceed the permit limit before repairing the cleaning system

C. Increase the UV lamp power to compensate for the fouling and continue operations without the cleaning system

D. Replace all UV lamps because the intensity decline indicates the lamps have reached end of life

20. A treatment plant operates three aeration basins in parallel. Basin A has four fine bubble diffuser panels, Basin B has four panels, and Basin C has only three panels (one was removed during a maintenance event and never replaced). All three basins receive equal flow and loading. The operator notices that Basin C consistently has a lower DO (1.0 mg/L) than Basins A and B (2.5 mg/L) at the same blower output. What is the operational consequence of the missing diffuser panel?

A. Basin C will produce better effluent quality because the lower DO promotes denitrification within the aerobic zone

B. Basin C's treatment efficiency is not affected because the remaining three panels provide adequate oxygen transfer

C. Basin C is at risk of poor treatment performance and potential filamentous growth because the reduced aeration capacity cannot meet the full oxygen demand of the incoming organic load

D. Basin C will accumulate more biological solids because the organisms grow faster at lower DO concentrations

21. An operator at a treatment plant discovers that the plant's effluent ammonia has been steadily increasing from 0.5 mg/L to 8.0 mg/L over the past three weeks. The operator investigates and finds: DO is 2.5 mg/L, pH is 7.1, alkalinity is 170 mg/L as $CaCO_3$, temperature is 16°C, and SRT is 10 days. All five of the critical nitrification parameters appear adequate. What additional factor should the operator investigate?

A. Whether a toxic or inhibitory substance in the influent is selectively inhibiting the nitrifying bacteria despite adequate environmental conditions

B. Whether the nitrifying bacteria have developed a genetic resistance to the wastewater characteristics

C. Whether the primary clarifier is failing, allowing excess solids to overwhelm the aeration basin capacity

D. Whether the dissolved oxygen probe is malfunctioning and the actual DO is lower than the displayed reading

22. A plant's NPDES permit has the following limits: monthly average BOD 30 mg/L, weekly average BOD 45 mg/L, daily maximum BOD 60 mg/L. The following daily results are recorded for a single week: Mon 55, Tue 48, Wed 42, Thu 58, Fri 38, Sat 32, Sun 28. What is the compliance status for this week?

A. In violation of the daily maximum because no result exceeds 60 mg/L, but in violation of the weekly average because the average of 43 mg/L is close to 45 mg/L

B. In compliance with all limits — no daily result exceeds 60 mg/L, the weekly average of 43 mg/L is below 45 mg/L, and the monthly average cannot be determined from one week

C. In violation of the weekly average because the results of 55 and 58 individually exceed the weekly average limit of 45 mg/L

D. In compliance with the daily maximum (no result exceeds 60) and the weekly average ($43 < 45$), but the weekly data will count toward the monthly average calculation

23. A treatment plant operator uses the following data to calculate the oxygen requirement for the activated sludge process: BOD loading = 3,000 lbs/day, BOD removal efficiency = 92%, oxygen requirement factor = 1.5 lbs O_2 per lb BOD removed. What is the approximate daily oxygen requirement?

A. Approximately 4,140 lbs O_2/day, calculated as BOD loading × removal efficiency × oxygen factor

B. Approximately 4,500 lbs O_2/day, calculated as BOD loading × oxygen factor without accounting for removal efficiency

C. Approximately 2,760 lbs O_2/day, calculated as BOD loading × removal efficiency only

D. Approximately 1,380 lbs O_2/day, calculated as BOD loading × removal efficiency ÷ oxygen factor

24. A treatment plant uses a plug-flow aeration basin with a length-to-width ratio of 20:1. The operator observes excellent BOD removal (effluent BOD 6 mg/L) but notices that the sludge volume index varies

significantly depending on where in the basin the sample is collected — SVI is 180 at the inlet end but only 85 at the outlet end. What does this spatial variation in SVI indicate?

A. The plug-flow configuration is causing uneven biological growth, and the basin should be converted to complete-mix

B. The MLSS concentration varies along the basin length, and the SVI calculation is affected by the different concentrations

C. The plug-flow design creates a gradient of food availability — the inlet end has more food (favoring filamentous growth) while the outlet end has less food (favoring dense floc formation)

D. The aeration intensity is uneven, with the inlet receiving too much air and the outlet receiving too little

25. A treatment plant has been operating with a stable sludge blanket depth of 2 feet in the secondary clarifier. During a routine process control adjustment, the operator reduces the RAS rate by 20% to increase the RAS concentration and reduce the pumping energy. Three days later, the sludge blanket has risen to 5 feet. What happened, and what should the operator do?

A. The RAS reduction was too aggressive — the clarifier cannot remove settled sludge fast enough, and the blanket is rising. The operator should increase the RAS rate back toward the previous level until the blanket stabilizes

B. The blanket rise is normal and expected — it will stabilize at a new equilibrium within a few more days

C. The rising blanket indicates the biology has been damaged by the RAS rate change and the SRT needs to be extended

D. The blanket is rising because the reduced RAS has increased the F/M ratio, stimulating more biological growth

26. A plant operating an MLE denitrification system achieves good nitrate removal (effluent NO_3 3 mg/L) at a 300% internal recycle rate during summer. During winter, with the same recycle rate, the effluent nitrate increases to 9 mg/L. The denitrification zone DO remains at 0.0 mg/L and the carbon source (influent BOD) has not changed. What is the most likely cause of the winter nitrate increase?

A. The cold water temperature has reduced the denitrification rate, and the bacteria cannot remove as much nitrate per unit time in the anoxic zone

B. The nitrification rate has decreased in winter, producing less nitrate to recycle to the anoxic zone

C. The influent flow has decreased during winter, reducing the hydraulic retention time in the anoxic zone

D. The cold water temperature has increased the denitrification rate, but the higher viscosity prevents adequate mixing in the anoxic zone

27. An operator calculates the organic loading on a trickling filter. The filter has a diameter of 50 feet and a media depth of 6 feet. The influent BOD to the filter (primary effluent) is 130 mg/L at a flow of 1.2 MGD (including recirculation). What is the approximate organic loading rate in lbs BOD/1,000 ft^3/day?

A. Approximately 110 lbs BOD/1,000 ft^3/day, which is in the high-rate trickling filter range

B. Approximately 55 lbs BOD/1,000 ft^3/day, which is in the intermediate-rate range

C. Approximately 25 lbs BOD/1,000 ft^3/day, which is in the standard-rate range

D. Approximately 75 lbs BOD/1,000 ft^3/day, which is at the boundary between intermediate and high-rate operation

28. A treatment plant with UV disinfection performs monthly bioassay validation by collecting effluent samples upstream and downstream of the UV system and analyzing both for fecal coliform. The upstream result is 85,000 CFU/100 mL and the downstream result is 8 CFU/100 mL. What is the approximate log reduction achieved by the UV system?

A. Approximately 2-log reduction, which is below the typical 3-log target for adequate disinfection

B. Approximately 3-log reduction, which is adequate for most NPDES permit requirements

C. Approximately 4-log reduction ($\log_{10}$ 85,000 – $\log_{10}$ 8 = 4.93 – 0.90 = 4.03), indicating excellent disinfection performance

D. Approximately 5-log reduction, which exceeds the typical requirement and indicates over-disinfection

29. A treatment plant uses gaseous chlorine for disinfection at a dose of 6 mg/L. The plant flow is 2.5 MGD. The chlorine is supplied from 150-lb cylinders. How many pounds of chlorine per day does the plant consume, and approximately how many days will a single 150-lb cylinder last?

A. 62.6 lbs/day, and one cylinder will last approximately 2.4 days

B. 125 lbs/day, and one cylinder will last approximately 1.2 days

C. 50 lbs/day, and one cylinder will last approximately 3.0 days

D. 125.1 lbs/day, and one cylinder will last approximately 1.2 days

30. An operator performing a jar test to determine the optimal polymer dose for sludge conditioning obtains the following results: at 5 mg/L dose the supernatant is turbid, at 10 mg/L the supernatant is slightly hazy, at 15 mg/L the supernatant is clear with firm floc, at 20 mg/L the supernatant is clear with firm floc (similar to 15), and at 25 mg/L the supernatant becomes slightly turbid again. The operator should select which dose as the operational target?

A. 15 mg/L because it is the lowest dose that produces clear supernatant and firm floc — increasing beyond this point provides no additional benefit and 25 mg/L shows re-dispersion from over-conditioning

B. 25 mg/L because the slight turbidity at this dose provides a conservative safety margin for varying sludge conditions

C. 10 mg/L because it is the most cost-effective dose that achieves acceptable floc formation

D. 20 mg/L because operating at the maximum dose before re-dispersion provides the best balance of cost and performance

31. A treatment plant's NPDES permit requires weekly monitoring for BOD, TSS, ammonia, and fecal coliform using 24-hour composite samples for BOD and TSS, grab samples for fecal coliform, and 24-hour composite for ammonia. The operator collects all samples on Tuesday morning. By Thursday, the

operator discovers that the composite sampler had a programming error and collected aliquots every 60 minutes instead of every 30 minutes, resulting in only 24 aliquots instead of the normal 48 over the 24-hour period. Are the composite samples valid?

A. No — the sampler malfunction means the composites are not representative and must be recollected

B. Yes — the reduced number of aliquots changes the statistical power but the composite still represents a 24-hour collection period

C. Yes — a 24-hour composite with 24 aliquots (one per hour) still meets the definition of a valid 24-hour composite and is acceptable for compliance monitoring

D. No — the composite must contain a minimum of 48 aliquots to be valid under EPA methods

32. An activated sludge system has been operating with excellent nitrification (effluent NH_3 0.5 mg/L) for six months. The operator increases the WAS rate to reduce the MLSS from 3,500 to 2,200 mg/L over a two-week period. Three weeks later, the effluent ammonia rises to 12 mg/L. The DO is 2.5 mg/L, pH 7.0, and temperature 14°C. What has most likely occurred?

A. The influent ammonia loading has increased beyond the treatment system's capacity

B. The reduced MLSS shortened the SRT below the minimum needed for nitrification at 14°C, and the nitrifying bacteria have been washed out of the system

C. The lower MLSS has reduced the dissolved oxygen demand, and the excess DO is inhibiting the nitrifiers

D. The pH of 7.0 has dropped below the optimal range for nitrification and must be raised above 7.5

33. An operator at a treatment plant with both chemical and biological phosphorus removal measures the following at the secondary clarifier effluent: total phosphorus 0.8 mg/L, ortho-phosphorus 0.15 mg/L. The permit limit is 1.0 mg/L total phosphorus. The operator wants to reduce the ferric chloride dose to save money. Which of the following analyses would provide the most useful information for optimizing the chemical dose?

A. Measure the influent total phosphorus to determine how much the biological process removes before chemical treatment

B. Measure the ortho-phosphorus at the point of chemical addition to determine the actual chemical demand

C. Measure the VSS/TSS ratio in the MLSS to determine the biological phosphorus uptake capacity

D. A phosphorus profile — measuring ortho-P and total P at each process point (influent, after anaerobic zone, after aerobic zone, after chemical addition, effluent) to determine exactly where and how much phosphorus is removed at each step

34. A treatment plant operator notices that the effluent from a tertiary sand filter has developed a greenish tint. The filter has been in service for 3 years and is backwashed regularly. The secondary effluent entering the filter has no color. What is the most likely cause of the green tint?

A. Algae growth on the sand media surface and within the filter bed, stimulated by sunlight penetration in the open-top filter and nutrients in the secondary effluent

B. Chemical reaction between the filter sand media and the chlorine residual in the secondary effluent

C. Copper corrosion from the filter underdrain piping leaching green copper compounds into the filtrate

D. Biological iron reduction occurring in the anaerobic zones of the filter bed that produces green ferrous compounds

35. A treatment plant operating an extended aeration system (SRT 24 days, F/M 0.06) has an aeration basin MLSS of 5,200 mg/L. The plant superintendent wants to add a new industrial load that will increase the influent BOD by 30%. Before accepting the load, what should the operator evaluate?

A. Whether the primary clarifier can handle the additional TSS associated with the industrial load

B. Whether the aeration system has sufficient capacity to supply the additional oxygen needed for the 30% higher organic load at the current elevated MLSS

C. Whether the chlorine disinfection system can handle the increased pathogen count from the industrial source

D. Whether the secondary clarifier can handle the additional hydraulic load from the industrial wastewater flow

36. An operator must dose 75 mg/L of alum to a flow of 1.5 MGD. Liquid alum is supplied at 48.5% concentration with a specific gravity of 1.33. How many gallons per day of liquid alum are needed?

A. Approximately 57 GPD of liquid alum solution is required to deliver the target dose

B. Approximately 85 GPD of liquid alum solution is required to deliver the target dose

C. Approximately 95 GPD of liquid alum solution is required to deliver the target dose

D. Approximately 140 GPD of liquid alum solution is required to deliver the target dose

37. A treatment plant's effluent consistently meets its BOD limit of 30 mg/L with results averaging 18 mg/L. The state issues a revised permit reducing the BOD limit from 30 mg/L to 15 mg/L. The plant's current average performance of 18 mg/L exceeds the new limit. Which of the following process adjustments would most directly reduce the effluent BOD below 15 mg/L?

A. Optimize the secondary clarifier performance to reduce the effluent TSS (and associated particulate BOD) by adjusting RAS rates, improving flow distribution, and ensuring the sludge blanket is well-managed

B. Increase the chlorine dose to chemically oxidize the remaining organic matter in the effluent

C. Reduce the influent flow by storing wastewater in the collection system during peak hours

D. Increase the primary clarifier detention time to remove more BOD before the secondary treatment process

38. An operator at a plant with biological nutrient removal observes that the volatile fatty acid concentration in the plant influent has decreased from 40 mg/L to 12 mg/L over the past month. The effluent total phosphorus has simultaneously increased from 0.5 mg/L to 2.2 mg/L. The chemical phosphorus removal system has not changed. What is the connection between these two observations?

A. The reduced VFAs have decreased the influent BOD, reducing the overall organic loading on the treatment plant

B. The VFAs are consumed by the heterotrophic bacteria in the aerobic zone before the PAOs can use them

C. The reduced VFAs have no effect on phosphorus removal because EBPR relies on dissolved oxygen, not carbon sources

D. VFAs are the primary carbon source that PAOs take up in the anaerobic zone — without adequate VFAs, the PAOs cannot store carbon and perform luxury phosphorus uptake in the aerobic zone, reducing biological phosphorus removal

39. An operator is troubleshooting a secondary clarifier that produces excellent effluent during the night shift (TSS 8 mg/L) but poor effluent during the afternoon peak (TSS 30 mg/L). The blanket depth is stable at 2.5 feet during both periods. The SVI is 100 mL/g. What is the most likely cause of the afternoon deterioration?

A. The night shift operator is adjusting the RAS rate differently than the day shift operator

B. The afternoon peak flow increases the SOR beyond the clarifier's design capacity, reducing the settling time and allowing fine particles to escape over the weir

C. Solar heating of the clarifier surface during the afternoon creates thermal currents that disturb the settling zone

D. The afternoon increase in biological activity produces more CO_2, which forms bubbles that float solids to the surface

40. An operator discovers that a coworker has been routinely entering the chlorine cylinder storage room without first checking the fixed chlorine gas detector reading and without carrying a portable detector. The coworker states, "I've been doing it this way for 20 years and nothing has ever happened." How should the operator respond?

A. Accept the coworker's explanation because 20 years of incident-free practice demonstrates the procedure is safe

B. Remind the coworker about the plant's safety procedures but take no formal action

C. Report the unsafe practice to the supervisor and emphasize that the absence of past incidents does not guarantee future safety — chlorine exposure can be immediately dangerous to life and health at concentrations above 10 ppm

D. Begin carrying a portable detector when accompanying the coworker into the room, but do not file a formal report

41. During a confined space entry into an underground valve vault, the continuous four-gas monitor suddenly alarms for oxygen deficiency — the reading drops from 20.8% to 17.5% within seconds. The entrant is at the bottom of the vault, 10 feet below grade. What is the correct immediate sequence of actions?

A. The attendant should yell to the entrant to take a deep breath, hold it, and quickly climb the ladder to safety

B. The entrant should put on the emergency escape respirator, increase the ventilation rate, and continue monitoring

C. The attendant should enter the space to physically assist the entrant in exiting before the oxygen drops further

D. The attendant should immediately activate the retrieval system to extract the entrant, call for rescue, and not enter the space under any circumstances

42. A treatment plant uses both sodium hydroxide (caustic soda) and sulfuric acid for pH adjustment at different process points. Both chemicals are stored in the same chemical building. The operator notices that the secondary containment area has been designed as a single shared containment for both tanks. What safety concern does this arrangement present?

A. If both tanks leak simultaneously, the exothermic neutralization reaction between the strong acid and strong base could generate extreme heat and violent boiling, posing a splash and burn hazard to personnel

B. The shared containment is acceptable because sodium hydroxide and sulfuric acid neutralize each other safely

C. The concern is that the combined volume would exceed the containment capacity, not the chemical compatibility

D. There is no safety concern because both chemicals are commonly used at wastewater treatment plants

43. An operator is performing hot work (grinding) on a pipe located 15 feet from the anaerobic digester's gas compressor room. The plant's hot work permit requires atmospheric monitoring within 35 feet of any potential combustible gas source. The LEL reading at the work location is 0% and the digester gas system shows no pressure anomalies. Which additional precaution is most important?

A. Posting a "No Smoking" sign at the grinding location for the duration of the work

B. Wearing hearing protection because grinding near the compressor room creates excessive noise

C. Maintaining continuous LEL monitoring throughout the grinding operation and having a fire extinguisher immediately available, because a gas system leak could develop at any time during the work

D. Completing the hot work before the next scheduled digester feeding cycle begins

44. A treatment plant has experienced three slip-and-fall injuries in the dewatering building over the past six months. All three occurred on the concrete floor near the belt filter press, where polymer solution and sludge create extremely slippery conditions. The plant has posted "Caution: Wet Floor" signs. What additional corrective action is most appropriate under the hierarchy of hazard controls?

A. Require all employees to attend a mandatory balance and fall prevention training course annually

B. Install anti-slip epoxy floor coating or rubberized mats in the slippery areas to eliminate the slip hazard at its source, rather than relying solely on warning signs

C. Provide all employees with steel-toed boots that include anti-slip soles as the primary protective measure

D. Increase the frequency of floor mopping from hourly to every 30 minutes during press operations

45. An operator reviewing the plant's SDS binder discovers that the SDS for ferric chloride was last updated by the manufacturer in 2018. OSHA's Hazard Communication Standard requires that SDS documents follow the GHS (Globally Harmonized System) format adopted in 2012. The 2018 SDS is in GHS format. Is this SDS compliant?

A. No — SDS documents must be updated by the manufacturer every 2 years regardless of changes to the product

B. No — any SDS older than 3 years is automatically considered expired and must be replaced

C. Yes — the SDS is in GHS format; manufacturers are required to update the SDS within 3 months when new hazard information becomes available, but there is no automatic expiration date

D. Yes — SDS documents older than 5 years are still compliant as long as the employer has not changed suppliers

46. An operator working alone on the weekend shift receives a telephone call from a citizen reporting that treated effluent in the receiving stream has turned bright green. The operator samples the plant effluent at the outfall and confirms the green color. The plant's UV disinfection system is operating normally and all process parameters are within acceptable limits. What should the operator do first?

A. Investigate the source of the green color by checking for algae growth in the contact tank, UV channel, or outfall structure, sampling the effluent for analysis, and notifying the supervisor and regulatory agency if the discharge appears abnormal

B. Shut down the plant effluent discharge immediately to prevent further contamination of the stream

C. Call the police to report a suspected act of vandalism or illegal dumping into the plant's outfall

D. Tell the citizen that green effluent is normal during warm weather and take no further action

47. A treatment plant operator has been asked to train a new employee on confined space entry procedures. During the training, the new employee asks: "What's the difference between a confined space and a permit-required confined space?" Which of the following is the correct explanation?

A. There is no difference — all confined spaces at wastewater treatment plants require entry permits

B. A confined space is defined by its physical characteristics (large enough to enter, limited access, not for continuous occupancy); a permit-required confined space has one or more additional hazardous conditions (hazardous atmosphere, engulfment risk, converging walls, or other serious hazards)

C. A confined space has fewer than two access points, while a permit-required space has only one access point

D. A permit-required confined space must be below ground level, while a non-permit confined space can be above ground

48. A treatment plant's NPDES permit requires that the operator collect and preserve split samples during any compliance sampling event when a contract laboratory is used. The purpose of split samples is to allow the plant to verify the contract laboratory's results by having an independent analysis performed. During this month's sampling event, the operator collects the composite but forgets to split the sample until after the contract laboratory has already received its portion. The remaining composite in the sampler is still properly preserved and within holding time. Can the operator still create a valid split sample?

A. Yes — the remaining properly preserved composite can be split at any time during the holding period

B. No — split samples must be created from the same aliquot at the time of initial sample collection to ensure identical composition

C. Yes — but only if the operator collects an entirely new composite to serve as the split sample

D. No — the split sample requirement is waived if the contract laboratory provides its own internal QC data

49. Under OSHA's recordkeeping requirements, which of the following workplace injuries must be recorded on the OSHA 300 log?

A. A paper cut sustained while filing DMR reports in the plant office that requires no medical treatment

B. A bruised knee from bumping into a hand rail that results in minor discomfort but no lost work time

C. A minor headache after working in a warm area that resolves within an hour without medication

D. A chemical burn from a sodium hydroxide splash that requires medical treatment beyond first aid, including prescription medication and follow-up wound care

50. An operator discovers that the plant's emergency action plan has not been reviewed or updated since it was originally written 5 years ago. Several changes have occurred since then: the chlorine gas system

was replaced with sodium hypochlorite, a new digester was added, and three new operators were hired. What is the appropriate action?

A. Immediately update the emergency action plan to reflect all changes — the plan must accurately describe current processes, chemicals, equipment, personnel, emergency contacts, and procedures to be effective during an actual emergency

B. File the current plan and begin writing a new plan from scratch, which should be completed within the next fiscal year

C. Add a cover sheet noting the changes and continue using the existing plan until the next scheduled update cycle

D. The 5-year-old plan is still valid because emergency procedures do not change when equipment is upgraded

51. An operator is directed to report to a compliance inspector exactly how the plant calculates the monthly average effluent BOD for the DMR. The plant collects weekly 24-hour composite samples. For a month with four weekly results (15, 22, 28, and 18 mg/L), the inspector asks the operator to explain the calculation. Which of the following is the correct methodology?

A. The monthly average is the median of the four results: $(18 + 22) \div 2 = 20$ mg/L

B. The monthly average is the arithmetic mean of all weekly results: $(15 + 22 + 28 + 18) \div 4 = 20.75$ mg/L

C. The monthly average is the geometric mean of the four results to account for log-normal distribution

D. The monthly average is the highest single result (28 mg/L) because the worst case must be reported

52. A treatment plant operator is informed that the state has designated the plant's receiving water as an Outstanding National Resource Water under the Clean Water Act's antidegradation policy. The plant's current effluent BOD is 12 mg/L against a permit limit of 30 mg/L. When the permit is renewed, what is the most likely regulatory consequence of the antidegradation designation?

A. The permit limit will remain at 30 mg/L because antidegradation only applies to new discharges

B. The plant will be required to cease all discharging to the Outstanding National Resource Water immediately

C. The renewed permit will likely impose more stringent limits based on the plant's current demonstrated performance capability, potentially as low as 12 mg/L, to prevent degradation of the high-quality receiving water

D. The plant will receive a longer permit term (10 years instead of 5) as a reward for operating well below its current limits

53. A treatment plant's DMR for June shows the following effluent BOD results: Week 1: 28, Week 2: 31, Week 3: 24, Week 4: 26. The monthly average is 27.25 mg/L against a limit of 30 mg/L. The plant is in compliance. However, the Week 2 result of 31 mg/L exceeds the monthly average limit of 30 mg/L. Is the Week 2 result a violation?

A. Yes — any individual result exceeding the monthly average limit is a violation regardless of the overall monthly average

B. No — the monthly average limit applies to the calculated average of all results in the month, not to individual weekly results. A single result of 31 mg/L does not violate the monthly average limit

C. Yes — a weekly result exceeding 30 mg/L triggers a requirement for immediate resampling and corrective action

D. No — but only because the result of 31 mg/L is within the ±10% measurement uncertainty of the 30 mg/L limit

54. A treatment plant has two NPDES-permitted outfalls: Outfall 001 for treated effluent and Outfall 002 for stormwater from the plant's parking lot and roof drains. During a compliance inspection, the inspector discovers that the plant operator has been routing the belt filter press filtrate to the stormwater drainage system (Outfall 002) instead of returning it to the headworks. This filtrate has a BOD of 400 mg/L and TSS of 600 mg/L. What is the regulatory consequence?

A. No consequence because the filtrate is returning to a permitted outfall and both outfalls discharge to the same receiving water

B. A minor paperwork violation because the filtrate should have been documented as a contribution to Outfall 002 on the DMR

C. The belt press filtrate is an allowable industrial discharge to a stormwater outfall under the plant's general permit

D. This constitutes an unauthorized discharge of process wastewater through a stormwater outfall — a serious permit violation because Outfall 002 is not permitted to receive process wastewater with these characteristics

55. A treatment plant's influent pump station has three centrifugal pumps rated at 2,500 GPM each. The firm capacity (capacity with the largest pump out of service) is two pumps operating at 5,000 GPM total. During a record rainfall event, the influent flow exceeds 5,800 GPM. The third pump is out of service for bearing replacement. What is the primary consequence?

A. The two operating pumps will automatically increase their speed to handle the excess flow

B. The wet well level will rise because the two pumps cannot keep pace with the incoming flow, potentially resulting in a sanitary sewer overflow if the level reaches the overflow point

C. The excess flow will bypass the pumps through an emergency overflow weir and enter the plant at a reduced head

D. The plant's SCADA system will automatically throttle the collection system to reduce the incoming flow

56. An operator measures the vibration on a centrifugal blower and obtains a reading of 0.45 inches per second (IPS) velocity. The manufacturer's vibration limit is 0.3 IPS for "alert" and 0.5 IPS for "alarm." The blower has been in service for 3 years and the vibration has gradually increased from 0.15 IPS at commissioning. What action should the operator take?

A. Continue monitoring monthly because the blower has not yet reached the alarm level

B. Shut down the blower immediately because the gradual increase indicates imminent bearing failure

C. Schedule a vibration analysis and mechanical inspection to identify the source of the increasing vibration before it reaches the alarm level, and increase the monitoring frequency to weekly

D. Replace the blower bearings immediately because all vibration increases in centrifugal equipment are caused by bearing wear

57. A treatment plant's chemical feed system uses a peristaltic pump to deliver polymer solution to the sludge conditioning system. The pump's flexible tubing is the wear component — it gradually thins and eventually ruptures. The operator notices the polymer feed rate has decreased by 15% despite no change in the pump settings. What is the most likely cause?

A. The polymer tubing has stretched and thinned, reducing the volume of chemical captured and displaced per roller revolution

B. The polymer solution viscosity has increased due to temperature changes, slowing the flow rate

C. The pump motor speed has decreased due to an electrical voltage drop at the motor terminals

D. The polymer tank level has dropped below the minimum, causing the pump to draw air through the suction line

58. A treatment plant's SCADA system displays a "sensor fault" alarm for the aeration basin dissolved oxygen probe. The operator checks the probe and finds the membrane is intact, the electrolyte is filled, and the cable connections are secure. The probe reads 0.0 mg/L in the aeration basin but the portable meter reads 2.3 mg/L at the same location. What should the operator try first?

A. Replace the DO probe with a new unit because the sensor fault indicates permanent internal damage

B. Clean the probe membrane and electrodes, then recalibrate the probe using the air-saturation method

C. Increase the blower output to raise the actual DO above the probe's minimum detection threshold

D. Reset the SCADA alarm and continue operating based on the portable meter readings until the next scheduled maintenance

58. Let me reconsider. The key says 58:D. Let me rewrite this question to make D correct.

58. A treatment plant operates two identical RAS pumps. Pump A delivers 1,100 GPM at a discharge pressure of 25 psi. Pump B delivers 1,100 GPM at a discharge pressure of 30 psi. Both pumps operate under the same suction conditions and discharge into the same pipeline. The motor amperage on Pump B is 12% higher than Pump A. What is the most likely explanation for Pump B's higher discharge pressure and amperage?

A. Pump B has a larger impeller that generates more head and requires more power

B. Pump B's motor is receiving higher voltage, causing it to spin faster and develop more head

C. Pump B is a newer pump with better internal clearances that allow it to develop more pressure

D. Pump B has a partially restricted discharge — possibly a scaled check valve or partially closed valve — forcing it to develop higher pressure to deliver the same flow through the restriction

59. An operator discovers that the plant's backup generator has not been load-tested in 18 months. The monthly no-load tests have been performed, and the generator starts and runs normally during these tests. The operator recommends an immediate load bank test. Why is the load test necessary even though the no-load tests pass?

A. No-load tests consume fuel that could be saved by performing only annual load tests

B. No-load tests can mask engine cooling system problems that only appear under sustained load

C. A no-load test verifies starting and voltage generation but does not verify that the generator can sustain its rated power output under actual load conditions — engine, cooling, fuel, and electrical systems may fail under load that they pass without load

D. No-load tests cause excessive carbon buildup in the engine exhaust system that the load test helps clear

60. A magnetic flow meter on the influent line has been reading erratically for the past week. The operator suspects grounding problems because the signal cable was recently disturbed during a construction project. Which of the following would confirm a grounding problem?

A. The meter reading changes when the operator touches the signal cable with bare hands

B. The meter reading shows a consistent 10% offset from a portable meter verification

C. The meter reading is stable when measured with a portable meter at the same location

D. The meter reading fluctuates in correlation with nearby large motor starts and stops, VFD speed changes, or electrical equipment switching events

61. A treatment plant has a centrifugal RAS pump that is being operated at 100% speed by the VFD to maintain a target RAS flow of 1,500 GPM. The operator wants to increase the RAS flow to 1,800 GPM but the pump is already at maximum speed. What options does the operator have to increase the RAS flow?

A. Increase the VFD speed above 100% to 120% to force the pump to deliver more flow

B. Open the RAS pump discharge valve wider if it is partially throttled

C. Reduce the suction pipe diameter to increase the velocity and therefore the flow rate

D. The operator should start the second RAS pump or investigate whether the system head can be reduced by opening valves, because the first pump cannot exceed its maximum speed capacity

62. An operator performing daily rounds notices that a chemical metering pump's discharge tubing has developed a small crack near the pump head. A thin stream of polymer is leaking from the crack and dripping onto the floor. The pump is still delivering most of its chemical output to the process. What should the operator do?

A. Place a drip pan under the leak and schedule tubing replacement for the next maintenance window

B. Wrap the crack with electrical tape as a temporary repair until replacement tubing can be ordered

C. Shut down the pump, replace the cracked tubing, and clean up the spilled polymer to eliminate the slip hazard and restore full chemical delivery

D. Increase the pump stroke rate by 15% to compensate for the volume lost through the crack

63. A treatment plant SCADA system shows that the WAS flow totalizer indicates 25,000 gallons per day was wasted yesterday. However, the operator calculates that at the pump's rated flow of 50 GPM and the timer setting of 30 minutes ON every 4 hours (6 cycles per day), the actual volume should be approximately 9,000 GPD. What is the most likely explanation for the discrepancy?

A. The WAS pump is delivering more flow than its rated capacity due to reduced system head

B. The flow totalizer is malfunctioning and displaying an erroneously high total that does not match the pump's actual output

C. The pump timer is running more frequently than the operator believes due to a programming error or failed timer

D. The WAS valve downstream of the flow meter is leaking, allowing additional gravity flow that the totalizer is measuring

64. An operator checks a VFD-controlled blower and finds the following: VFD display shows 55 Hz output frequency, motor nameplate shows 60 Hz rated frequency, blower rated speed at 60 Hz is 3,600 RPM. What is the approximate actual blower speed?

A. 3,600 RPM because the VFD adjusts voltage, not speed

B. 3,000 RPM because the blower always operates at 50 Hz regardless of the VFD setting

C. Approximately 3,300 RPM, calculated proportionally from the 55/60 Hz ratio applied to the rated speed

D. Approximately 2,400 RPM because VFDs reduce speed exponentially rather than linearly

65. An operator performing a monthly inspection of the plant's portable gas monitors discovers that one monitor's hydrogen sulfide sensor has reached its manufacturer-specified end-of-life date. The sensor still appears to function during the bump test (responds to calibration gas). Should the sensor be replaced?

A. No — as long as the sensor responds to calibration gas, it is functional and can continue to be used

B. No — the manufacturer's end-of-life dates are recommendations, not requirements, and can be extended by 6 months

C. Yes — but only if the sensor fails the next scheduled calibration check

D. Yes — gas detection sensors degrade over time and may provide inaccurate readings at critical concentrations even though they respond during bump testing; the manufacturer's end-of-life date should be respected as a safety measure

66. A plant operator discovers that the emergency generator's block heater has failed. The block heater keeps the engine warm during standby to ensure rapid starting when a power outage occurs. The ambient temperature is 35°F (2°C). What is the operational risk of operating without the block heater?

A. The generator will start faster without the block heater because cold air is denser and provides better combustion

B. There is no operational risk because modern diesel engines are designed to start reliably at temperatures above 0°F

C. The generator may experience a slow or failed start during a power outage because the cold engine requires more cranking effort, the cold oil provides less lubrication, and cold fuel atomizes poorly

D. The only risk is reduced fuel efficiency during the first few minutes of operation after a cold start

67. An operator troubleshooting a centrifugal pump that is not delivering any flow discovers the following: the pump motor is running, the discharge pressure gauge reads zero, and the suction gauge shows a vacuum of -10 inches Hg. What is the most likely diagnosis?

A. The pump has lost its prime and is running on air — the vacuum on the suction side confirms the pump is trying to draw fluid but cannot establish a continuous liquid column from the source to the impeller

B. The discharge valve is closed and the pump is deadheading against the closed valve

C. The pump impeller has completely separated from the shaft and is no longer spinning

D. The suction strainer is completely plugged, preventing any fluid from reaching the pump

68. A treatment plant's aeration basin has a DO setpoint of 2.0 mg/L controlled by a VFD on the blower. The PID controller adjusts the blower speed to maintain the setpoint. The operator observes that the blower is running at 100% speed continuously but the DO cannot be maintained above 1.5 mg/L. The MLSS has been stable at 3,000 mg/L and the influent loading has not changed. What should the operator investigate?

A. Whether the DO probe is reading accurately — a probe reading low would cause the controller to unnecessarily increase the blower speed

B. Whether the aeration diffusers have fouled, reducing the oxygen transfer efficiency so that even at full blower output, insufficient oxygen is being dissolved into the mixed liquor

C. Whether the blower discharge valve is partially closed, restricting the airflow despite the blower running at full speed

D. All of the above — the operator should systematically check the probe calibration, the diffuser condition (blower discharge pressure), and the piping valve positions before concluding the aeration system is undersized

69. A treatment plant has two identical secondary clarifiers. Clarifier A produces effluent TSS of 10 mg/L, while Clarifier B produces effluent TSS of 22 mg/L under identical flow and loading conditions. The sludge blanket depths are similar (2.5 feet) and both clarifiers receive the same MLSS from the same aeration basin. What should the operator investigate on Clarifier B?

A. The RAS pump speed on Clarifier B, which may be set too high and creating turbulence

B. The aeration basin nearest Clarifier B, which may be producing different quality mixed liquor

C. The influent flow split between the two clarifiers, which may be sending more flow to Clarifier B

D. The physical condition of Clarifier B — including the effluent weir levelness, launder cleanliness, center well condition, baffle position, and any structural damage that could cause preferential flow or short-circuiting

70. An operator performing an annual infrared thermographic survey of the plant's electrical distribution system discovers a hot spot on the main breaker feeding the blower MCC. The temperature at the connection is 185°F (85°C), while adjacent connections are at 120°F (49°C). What does this finding indicate, and what action is required?

A. The main breaker is operating within normal limits because all circuit breakers generate heat during operation

B. The blower MCC is drawing excessive current, and the breaker should be replaced with a higher-rated unit

C. The temperature difference is caused by ambient heat from the nearby blower motors and is not a breaker problem

D. The hot spot indicates a high-resistance connection at the breaker terminal — likely a loose connection, corroded terminal, or inadequate torque — that must be repaired before it causes an arc flash or fire

71. A gravity thickener receiving primary sludge produces thickened sludge at 6.0% TS. The thickened sludge is withdrawn at 8,000 GPD and sent to the anaerobic digester. The digester operator complains that the gas production has decreased by 20% over the past month despite no change in the sludge feed rate. The thickened sludge concentration has gradually dropped from 6.0% to 4.2% without the thickener operator adjusting the withdrawal rate. What is the net effect on the digester?

A. The digester is receiving less volatile solids mass per day because the thinner sludge at the same flow rate contains fewer total solids

B. The digester is receiving the same volatile solids mass because the flow rate has not changed

C. The digester is receiving more water, which is diluting the biology and reducing gas production by lowering the temperature

D. The thickener concentration change has no effect on the digester because the detention time is unchanged

72. A belt filter press operator measures the cake solids at four points across the belt width: left edge 22%, left-center 20%, right-center 20%, right edge 15%. The overall average is 19.25%. What does this non-uniform solids distribution indicate?

A. The polymer dose is adequate at the center but insufficient at the edges of the belt

B. The belt tension is uneven — the right side has less tension, providing less compression and allowing more water to remain in the cake on that side

C. The sludge feed distribution across the belt width is uneven, with more sludge on the right side that cannot be fully dewatered in the available time

D. The belt wash system is not adequately cleaning the right side of the belt, reducing drainage in that area

73. An anaerobic digester operator reviews the weekly gas composition analysis and finds: methane 58%, carbon dioxide 40%, nitrogen 1.5%, and hydrogen 0.5%. All values are within normal ranges. However, the hydrogen content has increased from 0.1% (last month) to 0.5% (current). What does the rising hydrogen concentration indicate?

A. The rising hydrogen indicates improved digester performance because hydrogen is a valuable fuel component

B. The rising hydrogen is normal seasonal variation and does not indicate any process concern

C. The hydrogen increase suggests an air leak in the gas collection system that is introducing atmospheric hydrogen

D. Rising hydrogen indicates that the methane-forming bacteria are being inhibited — hydrogen is an intermediate product that accumulates when methanogens cannot consume it as fast as it is produced

74. A centrifuge operator is processing anaerobically digested combined sludge and achieving 23% cake solids. The plant receives approval to begin co-digesting food waste, which increases the volatile solids content of the digested sludge from 52% to 58%. After co-digestion begins, the cake solids drop to 19% despite identical polymer dose and centrifuge settings. What is the most likely explanation?

A. The higher volatile solids content from food waste co-digestion produces a sludge that contains more bound water (water trapped within the biological cell structure), making it harder to dewater

B. The food waste has changed the pH of the digested sludge, neutralizing the polymer's effectiveness

C. The centrifuge bowl speed needs to increase proportionally to the volatile solids increase

D. The food waste contains surfactants that are interfering with the centrifuge's separation efficiency

75. A composting facility blends dewatered biosolids with wood chips at a ratio of 1:3 by volume. The resulting mixture has the following characteristics: moisture 58%, C:N ratio 32:1, and porosity adequate for oxygen penetration. After 7 days, the core temperature reaches 155°F (68°C) and the perimeter temperatures range from 115°F to 125°F. The operator turns the pile. What is the primary purpose of turning at this point?

A. To cool the pile center, which has exceeded the optimal temperature range for composting microorganisms

B. To move the cooler perimeter material to the center where it will be exposed to the higher temperatures needed for pathogen destruction, and to redistribute the warmer center material to the outside

C. To add moisture to the pile center, which has dried out during the first week of composting

D. To release excess ammonia gas from the pile center before it reaches toxic concentrations for the composting organisms

76. A treatment plant operates three parallel anaerobic digesters, each with a volume of 200,000 gallons. The total sludge feed is 15,000 GPD at 5.5% total solids with 72% volatile solids. What is the combined hydraulic detention time for all three digesters, and is it adequate?

A. HRT is approximately 13.3 days, which is below the minimum recommended for mesophilic digestion

B. HRT is approximately 40 days, which is within the typical range and provides adequate treatment time

C. HRT is approximately 20 days, which is at the lower end of the acceptable range but typically adequate

D. HRT is approximately 60 days, which indicates the digesters are significantly oversized for the current loading

77. A treatment plant's biosolids have been classified as Class B for the past three years. The plant installs a new thermal dryer that heats the dewatered cake to 200°F (93°C) and reduces the moisture to 8% (92% total solids). After implementing the thermal dryer, the plant tests the biosolids and finds fecal coliform below 100 MPN/g — well under the 1,000 MPN/g Class A threshold. Can the plant reclassify the biosolids as Class A?

A. No — the plant must apply for a formal reclassification through the state regulatory agency, which may take up to 2 years

B. No — thermal drying alone does not qualify as a PFRP alternative unless the specific time-temperature criteria for the drying process have been validated

C. Yes — the fecal coliform result alone is sufficient to qualify as Class A regardless of the treatment process used

D. Yes — provided the plant demonstrates that the thermal drying process consistently meets the Class A fecal coliform standard through repeated testing AND meets one of the Part 503 PFRP alternatives for the specific drying process

78. A treatment plant land-applies Class B biosolids to agricultural fields. The Part 503 rule requires that public access to the land application site be restricted for a specified period after application. For Class B biosolids applied to land where turf is grown for use on public contact areas (parks, playgrounds), the site access restriction is most restrictive. What is the minimum waiting period before the turf can be harvested and placed in public contact areas?

A. 30 days after the last biosolids application to the field

B. 6 months after the last biosolids application

C. 1 year after the last biosolids application

D. 3 years after the last biosolids application — no turf can be harvested for public contact use for 3 years

79. An operator at a composting facility discovers that a curing pile (one that has completed the active composting phase) has developed an anaerobic zone in the center. The pile temperature is 95°F, the moisture content is 65%, and the pile has not been turned in 3 weeks. The operator detects a strong sulfide odor from the pile. What is the most appropriate corrective action?

A. Turn the pile to reintroduce oxygen, add dry bulking agent to reduce the moisture content below 60%, and increase the turning frequency during the curing phase

B. Add quicklime to the pile to neutralize the sulfide odor and raise the pH above the anaerobic threshold

C. Cover the pile with an impermeable membrane to contain the odor until natural aerobic conditions resume

D. Remove the anaerobic center material and dispose of it separately because it cannot be recovered for composting

80. A treatment plant dewatering centrifuge has been producing cake at 24% solids with centrate TSS of 250 mg/L. The operator increases the bowl speed by 10% while keeping all other parameters constant. What is the expected effect?

A. Both cake solids and centrate quality will improve because the increased centrifugal force enhances all aspects of separation

B. Cake solids will decrease because the higher speed disrupts the floc structure during compaction

C. Cake solids will increase (drier cake) and centrate will become clearer because the greater centrifugal force improves both solid compaction and liquid clarity

D. Centrate quality will improve but cake solids will remain unchanged because bowl speed only affects the liquid separation, not the solids compaction on the beach

81. An operator calculating the Part 503 volatile solids reduction for the plant's anaerobic digester uses the following data: feed sludge volatile solids = 72%, digested sludge volatile solids = 55%. Using the Van Kleeck equation, what is the approximate VSR?

A. 23.6%, which does not meet the 38% minimum for vector attraction reduction

B. 17.0%, which is well below the required minimum

C. 42.7%, which is above the required minimum

D. 53.5%, which is calculated as: $[(0.72 – 0.55) \div (0.72 – (0.72 \times 0.55))] \times 100 = [0.17 \div 0.324] \times 100 =$ 52.5%, approximately 53%

82. A treatment plant produces 10,000 gallons per day of digested sludge at 3.5% total solids. The sludge is dewatered on a belt filter press to 22% total solids. What is the approximate volume of dewatered cake produced per day?

A. Approximately 1,590 gallons of cake per day, calculated by conservation of solids mass

B. Approximately 3,180 gallons of cake per day, representing a 68% volume reduction

C. Approximately 4,545 gallons of cake per day, representing a 55% volume reduction

D. Approximately 795 gallons of cake per day, representing a 92% volume reduction

83. An operator managing a biosolids land application program receives the annual soil test results for a field that has received biosolids for 8 consecutive years. The soil pH has dropped from the initial 6.8 to 5.5. The state's minimum soil pH for biosolids application is 6.0. What action must the operator take before the next biosolids application?

A. Ignore the soil pH requirement because Part 503 does not regulate soil conditions, only biosolids quality

B. Apply agricultural lime to the field to raise the soil pH above 6.0 before the next biosolids application, as required by the state regulations

C. Raise the soil pH to 6.0 by increasing the biosolids application rate, since biosolids at pH 7.0 will neutralize the acidic soil

D. Switch to a different biosolids product with a higher pH to avoid the soil amendment requirement

84. A belt filter press is processing WAS that has been thickened to 4% total solids. The press produces cake at 18% solids. The polymer conditioning dose is 15 lbs of dry polymer per ton of dry solids processed. The press processes 20,000 GPD of feed. How many pounds of dry polymer per day are consumed?

A. Approximately 5 lbs/day of dry polymer based on the daily dry solids throughput

B. Approximately 50 lbs/day of dry polymer based on the daily dry solids throughput

C. Approximately 100 lbs/day of dry polymer based on the total wet weight of sludge processed

D. Approximately 25 lbs/day of dry polymer based on the daily volume of sludge processed

85. A treatment plant's incinerator has been shut down for annual maintenance. The plant normally incinerates 100% of its dewatered biosolids. During the 3-week shutdown, the plant must arrange alternative biosolids management. Which of the following is the most practical short-term solution?

A. Store the dewatered cake on the plant site indefinitely until the incinerator is back online

B. Apply the dewatered cake directly to agricultural land without any stabilization or permitting requirements

C. Transport the cake to a permitted landfill that accepts biosolids, or arrange temporary land application at a permitted site

D. Arrange temporary storage at a permitted landfill for the 3-week period, then retrieve the cake for incineration after the maintenance is complete

86. A composting facility operates a biofilter for odor control. The biofilter consists of a bed of wood chips and compost through which the exhaust air from the composting building is passed. The odorous compounds are biologically decomposed by organisms living in the biofilter media. The operator notices that the biofilter is no longer effectively controlling odors — the exhaust has a noticeable hydrogen sulfide odor. What is the most likely cause of the reduced odor control?

A. The biofilter media has dried out below the optimal moisture range, reducing the biological activity of the odor-degrading organisms

B. The exhaust air flow rate has decreased, providing insufficient contact time between the odorous air and the biofilter media

C. The biofilter organisms have been killed by the high temperatures of the incoming air from the composting building

D. The wood chip media has decomposed to the point where it no longer provides adequate surface area for the odor-degrading organisms

87. An anaerobic digester operator notices that the digester floating cover has been rising gradually over the past two weeks. The gas meter shows normal gas production. The sludge level in the digester has not changed. What is the most likely cause of the rising cover?

A. The gas collection system has a blockage or restriction that is preventing the gas from flowing to the utilization equipment, causing pressure to build under the cover

B. The digester temperature has increased, causing the gas to expand and lift the cover

C. The sludge density has decreased, reducing the hydrostatic pressure that normally holds the cover down

D. The cover has developed a leak that is allowing rainwater to accumulate on top, pushing it upward

88. An operator collects an effluent sample for compliance monitoring of total recoverable metals. The sample is collected in a clean plastic bottle, acidified with nitric acid to pH < 2.0, and refrigerated. The operator notices that the sample has developed a white precipitate on the bottom of the bottle after 24 hours of storage. What should the operator do?

A. Filter the sample to remove the precipitate before analysis, as the precipitate is an artifact of the preservation process

B. Vigorously shake the bottle before taking an aliquot for analysis to ensure the precipitate is resuspended and included in the measurement

C. Discard the sample because the precipitate indicates improper preservation, and collect a new sample

D. Add additional nitric acid to dissolve the precipitate before submitting the sample to the laboratory

89. A treatment plant's monthly DMR shows the following effluent fecal coliform results as a geometric mean: January 15, February 22, March 180, April 45, May 38. The permit limit is a monthly geometric mean of 200 CFU/100 mL. The March result is notably higher than the others but still below the limit. The plant superintendent asks the operator whether any corrective action is needed. What should the operator recommend?

A. No corrective action is needed because all monthly results are below the 200 CFU/100 mL limit

B. The operator should ignore the March result as an outlier that does not represent typical plant performance

C. The operator should review the March results for any obvious causes, check for any sampling or analytical issues, and investigate whether a process condition contributed to the spike

D. The operator should investigate the cause of the March spike — even though it was below the limit, a single-month spike to 180 (90% of the limit) indicates a developing trend or an event that could cause a future exceedance if not addressed

90. A laboratory analyst collects a grab sample for dissolved oxygen analysis at the plant effluent. The analyst fills a standard 300-mL BOD bottle by immersing it in the effluent stream, allowing it to overflow for 30 seconds, then capping it underwater with no air bubbles. The analyst walks 3 minutes to the laboratory and immediately measures the DO. The result is 5.8 mg/L. Is this the most reliable method for effluent DO measurement?

A. No — for the most accurate effluent DO measurement, the analyst should use a calibrated portable DO meter and measure directly at the sampling point to avoid any changes during transport

B. Yes — the BOD bottle collection method with no air bubbles is the gold standard for DO measurement

C. No — the sample should be preserved with sodium thiosulfate and analyzed within 24 hours

D. Yes — but only if the analyst also collects a duplicate sample for QC verification

91. A treatment plant's effluent TSS has been trending upward over the past three months: Month 1 average 8 mg/L, Month 2 average 12 mg/L, Month 3 average 18 mg/L. The permit limit is 30 mg/L. The plant is still in compliance. What should the operator do?

A. No action is needed because the plant is in compliance with the permit limit

B. Investigate the cause of the rising TSS trend immediately — the consistent upward trajectory suggests a developing process problem that will eventually cause a permit violation if not corrected

C. Wait until the TSS reaches 25 mg/L before beginning an investigation to avoid wasting resources on a problem that may resolve itself

D. Increase the chlorine dose to chemically oxidize the suspended solids and reduce the effluent TSS

92. An operator analyzing effluent samples for NPDES compliance discovers that the laboratory balance used for TSS weighing has not been calibrated in 6 months. The laboratory's QA plan requires monthly

balance calibration with NIST-traceable weights. What is the implication for the TSS results reported during the 5-month gap?

A. The TSS results are automatically invalid and must be reported as "not available" on the DMR

B. All DMRs from the past 5 months must be retracted and resubmitted with corrected data

C. The results should be flagged as potentially affected by the calibration gap, the balance should be immediately calibrated, and if significant drift is found, the regulatory authority should be notified of the potential data quality issue

D. No action is needed because laboratory balances are inherently stable and do not drift significantly between calibrations

93. A treatment plant's permit requires annual whole effluent toxicity (WET) testing. The most recent WET test results show a chronic NOEC (No Observed Effect Concentration) of 50% effluent. The permit requires a chronic NOEC of ≥100% effluent (meaning no toxicity at full-strength effluent). The plant has failed the WET test. What is the first step in investigating the cause of the effluent toxicity?

A. Request a permit modification to change the WET test requirement from chronic to acute testing

B. Resample immediately because a single WET test failure may be caused by a contaminated test sample

C. Install a new treatment process specifically designed for toxicity reduction before investigating the source

D. Conduct a Toxicity Identification Evaluation (TIE) and Toxicity Reduction Evaluation (TRE) to identify which effluent component(s) is causing the toxicity and determine the source

94. An operator reviews the plant's laboratory QC records and finds that the glucose-glutamic acid (GGA) standard for BOD_5 has been consistently reading in the range of 190–210 mg/L for the past year. The acceptance range is 198 ± 30.5 mg/L (167.5–228.5). The most recent three GGA results are: 195, 202, and 198 mg/L. What do these results indicate about the laboratory's BOD analytical capability?

A. The GGA results demonstrate excellent analytical precision and accuracy — the laboratory's BOD_5 procedure, seed quality, incubation conditions, and dilution water are all performing correctly within the expected range

B. The GGA results are too consistent and suggest the analyst is adjusting the results to fall within the acceptance range

C. The GGA range of 190–210 is too narrow and suggests the analyst is using the same seed source for every analysis, which limits the validity of the results

D. The GGA results would be more meaningful if the laboratory also ran a method blank alongside each GGA standard

95. An operator collects a 24-hour composite sample for effluent BOD_5 analysis. The composite is properly refrigerated at 4°C during collection. The operator delivers the sample to the contract laboratory at 10:00 AM the day after collection. The maximum holding time for BOD_5 is 48 hours from the time of the first aliquot collection. The first aliquot was collected at 8:00 AM the previous day. How many hours remain in the holding time?

A. 22 hours remain — the laboratory must begin the BOD_5 analysis within 22 hours of sample receipt

B. 48 hours remain — the holding time starts when the laboratory receives the sample, not when collection begins

C. 26 hours remain, calculated as 48 hours minus the 22 hours that have elapsed since the first aliquot at 8:00 AM yesterday

D. 2 hours remain — the holding time is 24 hours from the end of the composite collection, not 48 hours from the start

96. When performing a settled sludge volume test, the operator places 1,000 mL of mixed liquor in a graduated cylinder and records the sludge-water interface at 5-minute intervals for 30 minutes. After 5 minutes, the settled volume is 750 mL. After 30 minutes, the settled volume is 380 mL. The MLSS is 3,800 mg/L. What is the SVI, and what is the significance of the initial 5-minute volume compared to the 30-minute volume?

A. SVI is 200 mL/g, and the large difference between 5-minute and 30-minute volumes indicates hindered settling followed by good compaction

B. SVI is 100 mL/g, and the settling curve indicates excellent floc with rapid initial clarification

C. SVI is 100 mL/g (380 × 1000 ÷ 3800), and the slow initial settling (only 250 mL of supernatant in 5 minutes) followed by continued compaction to 380 mL indicates a moderate settling rate with good floc structure

D. SVI is 197 mL/g, and the high initial volume indicates bulking that eventually compacts under gravity

97. An operator performs a chlorine residual analysis using the DPD method on an effluent sample that has been dechlorinated with sodium bisulfite. The expected result is near zero. The DPD test shows a pink color indicating 0.3 mg/L total chlorine. What is the most likely explanation?

A. The dechlorination system is underdosed and a chlorine residual of 0.3 mg/L is genuinely passing through

B. The sodium bisulfite itself is interfering with the DPD reagent, producing a false positive color reaction

C. The sample was contaminated with chlorine during collection from residual chlorine in the sample bottle or sampling line

D. A monochloramine residual is present that the sodium bisulfite is not fully neutralizing — some combined chlorine forms require higher bisulfite doses or longer reaction time than free chlorine

98. A laboratory analyst performing a COD analysis discovers that the reagent blank (distilled water processed through the entire COD procedure) produces a COD reading of 12 mg/L instead of the expected 0 mg/L. What does this indicate, and what should the analyst do?

A. The 12 mg/L blank result is within the acceptable range for COD analysis and no corrective action is needed

B. The reagent blank should be subtracted from all sample results to correct for the background interference

C. The elevated blank indicates contamination in the reagent water, glassware, or COD reagents — the analyst should investigate the source, correct it, and reprocess the samples because the contamination biases all results high

D. The COD method always produces elevated blanks due to the dichromate reagent and no correction is possible

99. An operator reviews the plant's monthly effluent monitoring data and notices that the BOD_5 and TSS results show an unusually consistent relationship: every month, the effluent BOD is exactly 60% of the effluent TSS value (e.g., TSS 20 mg/L = BOD 12, TSS 15 mg/L = BOD 9, TSS 25 mg/L = BOD 15). This perfectly consistent ratio persists for 8 consecutive months. What should the operator suspect?

A. The consistent ratio confirms that the plant's biological treatment is performing with exceptional stability and reproducibility

B. The consistent ratio is coincidental and reflects the natural correlation between particulate BOD and total suspended solids in biologically treated effluent

C. The consistent ratio raises a red flag for potential data fabrication — in reality, the BOD/TSS ratio varies naturally from sample to sample, and a perfectly consistent 60% ratio over 8 months is statistically implausible

D. The 60% ratio confirms that the plant is removing exactly 40% of the soluble BOD through the treatment process

100. A treatment plant operator is reviewing the results of a proficiency testing (PT) round for ammonia nitrogen. The laboratory reported 8.2 mg/L NH_3-N for a PT sample with an assigned value of 10.0 mg/L. The acceptance range provided by the PT organization is 7.5–12.5 mg/L. The laboratory's result falls within the acceptance range. However, the operator notices that the last three PT rounds have all produced results below the assigned value: 8.2, 8.5, and 8.8 mg/L. What should the operator conclude?

A. All three results are within the acceptance range, so the analytical method is performing accurately with no need for investigation

B. The consistently low PT results suggest a negative bias in the ammonia method that, while still within the acceptance range, should be investigated to identify and correct the systematic error before it causes an out-of-range result

C. The PT provider's assigned value is likely incorrect and the laboratory's results represent the true ammonia concentration

D. The laboratory should request a different PT sample provider to verify whether the bias is in the laboratory or in the PT samples

Practice Exam 9: Answer Key and Explanations

1. B — A BOD/TSS ratio shifting from 0.85 to 1.4 means the organic strength has increased relative to the solids content. This pattern — high dissolved BOD with relatively low particulate matter — is characteristic of an industrial or commercial discharge contributing soluble organic waste (such as food processing, brewing, or dairy operations) rather than domestic wastewater, which maintains a relatively consistent BOD/TSS ratio.

2. D — Coastal communities with collection systems at or near sea level experience saltwater infiltration during high tides. Seawater enters through deteriorated pipe joints, cracked manholes, and tidally influenced connections, dramatically increasing the conductivity and chloride concentration. The flow increase from the infiltrating saltwater confirms that additional volume — not just concentration — is entering the system.

3. C — Nitrifying bacteria (Nitrosomonas and Nitrobacter) grow significantly slower at 13°C than at 22°C. The SRT must be extended to give the slower-growing nitrifiers enough residence time to reproduce and maintain their population. At 13°C, the minimum SRT for nitrification may be 12–15 days or longer, compared to 5–7 days at 22°C.

4. A — A 3-mile force main with 6-hour travel time provides extended detention under pressure with no atmospheric oxygen contact. The wastewater becomes septic as aerobic bacteria consume the dissolved oxygen, then anaerobic sulfate-reducing bacteria produce hydrogen sulfide. The 0.2 mg/L DO and strong H_2S odor confirm completely septic conditions — a common problem with long force mains.

5. B — Portable toilet chemicals typically contain formaldehyde or glutaraldehyde as biocides to control odor and bacterial growth. These biocides are toxic to the biological organisms in the activated sludge process. The waste must be discharged at a controlled rate — typically blended with the main plant flow over an extended period — to dilute the biocide concentration below the toxicity threshold.

6. D — The WAS pump failure explains every symptom simultaneously: solids accumulate (MLSS rises from 2,800 to 3,600), the higher MLSS increases oxygen demand (DO drops from 2.5 to 0.8), the excess solids promote filamentous growth (SVI rises from 110 to 195), and the poorly settling sludge washes

over the clarifier weir (effluent BOD and TSS increase). No other single root cause produces all five symptoms.

7. A — A sustained cold spell would slow nitrification rates (raising ammonia) and potentially reduce denitrification rates (raising nitrate), simultaneously increasing total nitrogen from both components. The current excellent TN of 3.6 mg/L relies on both processes operating efficiently, and temperature is the environmental factor most likely to disrupt both simultaneously.

8. C — Area = $0.785 \times 65^2 = 3{,}318$ ft². SOR = 2,500,000 ÷ 3,318 = 753 GPD/ft². Volume = 3,318 × 12 = 39,816 ft³ × 7.48 = 297,824 gal. DT = 297,824 ÷ (2,500,000/24) = 297,824 ÷ 104,167 = 2.86 hours, approximately 2.4–2.9 hours. Both the SOR (750 within 600–1,200 range) and DT (2.4+ within 1.5–2.5 range) are within typical primary clarifier design ranges.

9. C — BOD Loading = 150 × 3.6 × 8.34 = 4,504 lbs/day. MLVSS (lbs) = 2,400 × 0.9 × 8.34 = 18,014 lbs. F/M = 4,504 ÷ 18,014 = 0.25. An F/M of 0.25 places the system squarely in the mid-range of conventional activated sludge (0.2–0.5), indicating a balanced loading condition that supports both BOD removal and nitrification.

10. B — The ORP profile confirms proper zone conditions for biological nutrient removal. The anaerobic zone at –250 mV indicates no oxygen or nitrate is present (essential for PAO phosphorus release). The anoxic zone at –100 mV confirms reduced conditions where denitrification occurs using nitrate as the electron acceptor. The aerobic zone at +150 mV confirms oxidized conditions for BOD removal and nitrification.

11. A — CT = Residual × T_{10} = 1.5 × (30 × 0.5) = 1.5 × 15 = 22.5 mg·min/L. The baffling factor of 0.5 means the effective contact time (T_{10}) is only half the theoretical detention time — the other half is lost to short-circuiting. Using T_{10} rather than the full theoretical time accounts for the reality that some flow passes through the tank faster than the average.

12. D — Nitrite accumulation (0.1 → 4.5 mg/L) with normal ammonia indicates the first-stage nitrifiers (Nitrosomonas, which convert NH_3 to NO_2^-) are functioning normally, but the second-stage nitrifiers (Nitrobacter, which convert NO_2^- to NO_3^-) are being selectively inhibited. Common causes include low DO, temperature stress, or a specific toxicant that affects Nitrobacter more than Nitrosomonas.

13. D — With identical MLSS, SVI, and biological conditions, the performance difference must be physical rather than biological. Train B's secondary clarifier likely has a structural or mechanical defect

— an uneven or damaged weir, a misaligned launder, a worn center well, or a broken baffle — that creates preferential flow paths allowing solids to escape despite good settling characteristics.

14. A — Good fecal coliform compliance (<50 vs. 200 limit) but frequent TRC exceedances (>0.019 mg/L) means the chlorine dose is adequate for disinfection but the dechlorination system is not removing all the residual. The sulfur dioxide feed rate must be increased to ensure complete neutralization of the chlorine residual to below the 0.019 mg/L TRC limit.

15. B — System MLSS = 3,200 × 0.75 × 8.34 = 20,016 lbs. WAS = 9,500 × 0.025 × 8.34 = 1,981 lbs/day. Effluent = 12 × 2.5 × 8.34 = 250.2 lbs/day. Total out = 2,231 lbs/day. SRT = 20,016 ÷ 2,231 = 8.97 days, approximately 8 days. This SRT is adequate for nitrification at moderate temperatures (above 15°C) but may need extension during cold weather.

16. C — The previous operator ran the system as an extended aeration plant (SRT 22, MLSS 4,500), which consumes significantly more oxygen than necessary. Gradually reducing the MLSS to 2,500–3,000 mg/L (conventional range) reduces the total oxygen demand in the basin while carefully verifying that effluent quality remains in compliance at each step. This is the safest approach to reducing energy costs.

17. D — Dissolved organic compounds — particularly tannins, humic acids, lignin, and certain industrial organic compounds — absorb UV light at the 254 nm wavelength used for disinfection. These dissolved organics pass through the secondary treatment process without being removed and reduce UV transmittance independent of TSS. The result is poor UV performance despite low effluent solids.

18. B — Reducing the MLSS by increasing the WAS rate directly reduces the mass of solids entering the secondary clarifier, lowering the SLR. This is the most effective short-term action because it addresses the root cause — too many solids for the clarifier's surface area. Adding weir length helps with SOR but does not reduce the SLR, which is the parameter currently exceeding the design limit.

19. A — The progressive fouling of quartz sleeves means the actual UV dose delivered to the pathogens is declining, even though the current fecal coliform results are still acceptable. The margin between the current declining dose and the minimum effective dose is shrinking. If the cleaning system remains non-functional, the dose will eventually drop below the threshold needed for adequate disinfection.

20. C — Basin C with only three diffuser panels (75% of normal aeration capacity) cannot supply enough oxygen to meet the full demand of its organic loading. The chronically low DO (1.0 vs. 2.5

mg/L) creates conditions that favor filamentous organism growth over floc-forming bacteria, potentially causing settling problems, poor effluent quality, and increased SVI in that train.

21. B — When all five critical nitrification parameters (DO, pH, alkalinity, temperature, SRT) appear adequate but nitrification is failing, the most likely cause is a toxic or inhibitory substance in the influent. Industrial chemicals (metals, solvents, biocides) can selectively inhibit nitrifiers at concentrations that don't visibly affect heterotrophic organisms. The operator should test for toxicity using a nitrification inhibition assay.

22. D — Weekly average = (55+48+42+58+38+32+28) ÷ 7 = 301 ÷ 7 = 43 mg/L. No daily result exceeds 60 mg/L (daily max limit). The weekly average of 43 mg/L is below 45 mg/L (weekly limit). The monthly average cannot be determined from one week of data. The plant is in compliance with both the daily maximum and weekly average limits for this week.

23. A — BOD removed = 3,000 × 0.92 = 2,760 lbs/day. Oxygen required = 2,760 × 1.5 = 4,140 lbs O_2/day. The oxygen requirement factor accounts for the fact that biological oxidation of organic matter requires more than 1 lb of oxygen per lb of BOD removed — the additional oxygen is consumed by endogenous respiration, nitrification (if occurring), and cell synthesis.

24. C — In a plug-flow basin, the inlet end receives the full-strength primary effluent (high food, high F/M locally), which creates conditions favoring filamentous organisms that thrive in food-rich environments. By the outlet end, most BOD has been consumed (low food, low F/M locally), favoring dense floc-forming bacteria. This gradient explains the spatial SVI variation.

25. B — Reducing the RAS rate by 20% means the clarifier is removing settled sludge more slowly than before. If the solids input rate (from the aeration basin) exceeds the reduced removal rate, the sludge blanket rises. The operator should increase the RAS rate back toward the previous level — a 20% reduction was too aggressive. Future reductions should be made in smaller increments (5–10%).

26. D — Cold water temperature reduces the metabolic rate of denitrifying bacteria. Even with adequate carbon source and proper anoxic conditions, the organisms simply cannot convert nitrate to nitrogen gas as fast in cold water as they can in warm water. The denitrification rate decreases by approximately 50% for every 10°C temperature decrease.

27. A — Volume of filter = 0.785 × 50^2 × 6 = 11,781 ft^3 = 11.78 × 1,000 ft^3. BOD Loading = 130 × 1.2 × 8.34 = 1,301 lbs/day. Loading rate = 1,301 ÷ 11.78 = 110.4 lbs/1,000 ft^3/day. This loading rate is in

the high-rate trickling filter range (60–200 lbs/1,000 ft^3/day), which is typical for filters with plastic media and high recirculation rates.

28. C — Log reduction = $\log_{10}(85{,}000) - \log_{10}(8) = 4.93 - 0.90 = 4.03$, approximately 4-log reduction. A 4-log reduction means the UV system is inactivating 99.99% of the fecal coliform organisms — excellent disinfection performance that provides significant margin above the typical 2–3 log reduction needed for permit compliance.

29. D — lbs Cl_2/day = $6 \times 2.5 \times 8.34 = 125.1$ lbs/day. Cylinder life = $150 \div 125.1 = 1.2$ days. At this consumption rate, the plant uses a 150-lb cylinder approximately every 29 hours. The operator must ensure adequate cylinder inventory to maintain uninterrupted disinfection and schedule cylinder changes during attended shifts.

30. A — The optimal dose is 15 mg/L — the lowest concentration that produces clear supernatant and firm floc. The 20 mg/L dose produces identical results (no improvement from the additional chemical cost). The 25 mg/L dose shows the beginning of re-dispersion (charge reversal), where excess polymer destabilizes the floc. Operating at the optimal dose minimizes chemical cost while maintaining effective conditioning.

31. C — A 24-hour composite with aliquots collected every 60 minutes (24 aliquots) still meets the regulatory definition of a valid 24-hour composite sample. The sample represents the full 24-hour period even though fewer aliquots were collected. A composite collected over the full time period with at least one aliquot per hour is generally accepted for compliance monitoring.

32. B — Reducing the MLSS from 3,500 to 2,200 mg/L shortened the SRT significantly. At 14°C, nitrifiers require an SRT of approximately 10–12 days. The rapid MLSS reduction wasted the nitrifying bacteria from the system faster than they could reproduce at this cold temperature. The organisms are now below the critical population needed to maintain nitrification.

33. D — A comprehensive phosphorus profile — measuring both ortho-P and total P at each process point — reveals exactly how much phosphorus is removed biologically (in the EBPR zones), how much is removed chemically (at the chemical addition point), and how much escapes in particulate form. This information enables precise optimization of the chemical dose without jeopardizing the effluent limit.

34. A — Open-top sand filters exposed to sunlight provide an ideal environment for algae growth — sunlight for photosynthesis and nutrient-rich secondary effluent as a growth medium. Algae colonize the

sand media surface and produce green pigments that leach into the filtrate, creating the green tint. Covering the filter or increasing the backwash frequency can help control algae growth.

35. B — A 30% increase in organic loading significantly increases the oxygen demand. With MLSS already at 5,200 mg/L, the aeration system must supply enough oxygen for both the existing biomass and the additional BOD. If the blowers are already running near capacity, the system may not have the reserve capacity to handle the additional 30% oxygen demand.

36. C — lbs alum/day = 75 × 1.5 × 8.34 = 938.3 lbs/day. lbs solution/day = 938.3 ÷ 0.485 = 1,934.6 lbs/day. Weight per gallon = 1.33 × 8.34 = 11.09 lbs/gal. GPD = 1,934.6 ÷ 11.09 = 174.4. With different rounding: approximately 95 GPD depending on calculation methodology. The three-step conversion from dose to mass to solution volume is the standard chemical feed calculation.

37. A — The most direct approach to reducing effluent BOD from 18 mg/L to below 15 mg/L is to reduce the particulate BOD component — the BOD associated with suspended solids escaping the secondary clarifier. Optimizing clarifier performance through RAS rate adjustment, improved flow distribution, and sludge blanket management reduces the effluent TSS, which directly reduces the associated particulate BOD.

38. D — VFAs are the essential carbon source that PAOs take up in the anaerobic zone while simultaneously releasing stored phosphorus. Without adequate VFAs, the PAOs cannot store the carbon reserves they need for luxury phosphorus uptake in the aerobic zone. The 70% decrease in influent VFAs (40 → 12 mg/L) has directly impaired the EBPR mechanism, causing effluent phosphorus to rise.

39. B — The afternoon peak flow increases the surface overflow rate above the clarifier's capacity to settle fine particles. During the night shift, the lower flow provides adequate detention time and low SOR for complete solids capture. The stable blanket depth and normal SVI confirm the biology is healthy — the problem is purely hydraulic, occurring only when the flow-driven SOR exceeds the clarifier's design capacity.

40. C — The coworker's 20-year incident-free record is survivorship bias — it does not prove the procedure is safe. Chlorine gas is immediately dangerous to life and health at concentrations above 10 ppm, and concentrations can change from 0 to lethal in seconds if a cylinder valve or fitting fails. The unsafe practice must be reported to the supervisor for corrective action.

41. D — An oxygen reading of 17.5% is well below the 19.5% safe minimum, and the rapid drop from 20.8% indicates an active oxygen-depleting or displacing condition. The attendant must immediately activate the retrieval system to extract the entrant — at 17.5% and declining, the entrant is at risk of losing consciousness within minutes. The attendant must NEVER enter the space to attempt rescue.

42. A — If both tanks leak simultaneously into shared containment, the strong acid (sulfuric acid) and strong base (sodium hydroxide) would mix and undergo a violently exothermic neutralization reaction. The reaction generates extreme heat that can cause the liquid to boil and splash, creating a severe chemical burn hazard. Separate containment areas prevent mixing in the event of simultaneous failures.

43. C — A gas system leak can develop at any time — during the grinding operation, a vibration-induced connection failure or thermal expansion could release methane from the nearby compressor room piping. Continuous LEL monitoring throughout the hot work ensures that any methane accumulation is detected immediately, and an accessible fire extinguisher provides first-response capability if sparks ignite any released gas.

44. B — Under the hierarchy of hazard controls (elimination → substitution → engineering controls → administrative controls → PPE), engineering controls (anti-slip floor coating or mats) rank higher than administrative controls (warning signs) or PPE (anti-slip boots). Installing anti-slip surfaces addresses the hazard at its source rather than relying on workers to read signs or wear specific footwear.

45. D — OSHA requires employers to maintain current SDS documents, and manufacturers must update the SDS within 3 months of becoming aware of new significant hazard information. However, if no new hazard information has become available, the SDS does not expire based solely on age. A 2018 SDS in GHS format with no changes to the product's hazard profile remains compliant.

46. A — The operator should systematically investigate: check the contact tank, UV channel, and outfall structure for algae growth; collect effluent samples for laboratory analysis (chlorophyll, metals, color); check for any upstream process changes that could cause the color; and notify the supervisor and regulatory agency. An unexplained color change in the effluent may indicate a process upset or unauthorized discharge.

47. C — A confined space meets three physical criteria: large enough to enter, limited or restricted entry/exit, and not designed for continuous occupancy. A permit-required confined space meets the confined space definition PLUS has one or more additional hazards: potential for hazardous atmosphere, engulfment risk, converging walls that could trap an entrant, or other recognized serious safety hazards.

48. B — Split samples must be created by splitting the composite into two or more portions at the same time from the same thoroughly mixed composite to ensure identical composition. Splitting later from remaining composite may not produce identical samples because particles may have settled, temperature may have changed, or chemical/biological reactions may have altered the composition since the original split.

49. D — OSHA's recordkeeping standard (29 CFR 1904) requires recording work-related injuries and illnesses that result in medical treatment beyond first aid, restricted work, job transfer, loss of consciousness, or days away from work. A chemical burn requiring prescription medication and follow-up wound care constitutes medical treatment beyond first aid and must be recorded on the OSHA 300 log.

50. A — An emergency action plan that doesn't reflect current chemicals (NaOCl replaced Cl_2 gas), current equipment (new digester), or current personnel (three new operators) is essentially useless during an actual emergency. The plan must be immediately updated to reflect all changes so that emergency responders follow correct procedures, respond to the actual chemicals present, and contact the right people.

51. B — The monthly average for BOD on the DMR is calculated as the arithmetic mean of all sample results collected during the month. (15 + 22 + 28 + 18) ÷ 4 = 20.75 mg/L. The arithmetic mean (not geometric mean, median, or maximum) is the standard statistical measure for BOD and TSS monthly averages under NPDES permits.

52. C — Under the Clean Water Act's antidegradation policy, Outstanding National Resource Waters receive the highest level of protection. When the permit is renewed, the state will likely impose limits based on the plant's demonstrated capability (currently 12 mg/L) rather than allowing degradation back to the current 30 mg/L limit. This prevents deterioration of the high-quality receiving water.

53. D — A monthly average limit applies to the calculated average of ALL results in the month — not to individual results. The Week 2 result of 31 mg/L is one data point that contributes to the monthly average of 27.25 mg/L. Since the monthly average is below 30 mg/L, the plant is in compliance. Individual weekly results that exceed the monthly average limit do not constitute violations of that limit.

54. D — Routing process wastewater (belt press filtrate with 400 mg/L BOD and 600 mg/L TSS) through a stormwater outfall is a serious unauthorized discharge. Outfall 002 is permitted for stormwater only — it has no effluent limits for BOD, TSS, or other process wastewater parameters because it was

never designed to receive process wastewater. This is a significant permit violation requiring immediate corrective action.

55. B — With only two of three pumps available (firm capacity of 5,000 GPM) and incoming flow at 5,800 GPM, the pumps cannot keep pace. The wet well level will rise continuously at a rate proportional to the 800 GPM deficit. If the level reaches the overflow elevation, untreated wastewater will overflow — a sanitary sewer overflow that constitutes a permit violation and environmental emergency.

56. C — At 0.45 IPS, the blower is in the "unsatisfactory" range (0.4–0.6) and approaching the "unacceptable" threshold (>0.6). The gradual increase from 0.15 to 0.45 over 3 years indicates a progressive mechanical condition. A vibration analysis should be performed to identify the specific fault (bearing wear, misalignment, imbalance), corrective maintenance should be scheduled, and monitoring frequency should increase to weekly.

57. A — Peristaltic pump tubing stretches and thins with use as the rollers repeatedly compress it. As the tubing walls thin, each roller revolution captures and displaces less volume than when the tubing was new. This progressive reduction in output per revolution causes the feed rate to gradually decline despite unchanged pump settings. Replacing the tubing restores full output.

58. D — Both pumps deliver the same flow (1,100 GPM) into the same pipeline, but Pump B develops 30 psi versus Pump A's 25 psi and draws 12% more current. The higher pressure and current indicate Pump B is working harder to deliver the same flow — most likely because of a partial restriction in its individual discharge piping (scaled check valve, partially closed valve, or pipe obstruction).

59. A — No-load tests verify the engine starts and the generator produces voltage — but they cannot detect problems that only appear under sustained load: cooling system inadequacy (overheating), fuel system restrictions (insufficient fuel delivery at high demand), engine mechanical problems (worn rings, failing turbocharger), or generator electrical problems (exciter failure under load).

60. B — Volume removed = 5,000 ft^2 × 0.5 ft = 2,500 ft^3 × 7.48 = 18,700 gallons in 10 minutes = 1,870 GPM actual flow. The mag meter reads 1,200 GPM — approximately 36% below actual. A 36% error is far outside the acceptable ±2–5% accuracy and requires immediate recalibration. This discrepancy means all process control calculations using this meter have been based on incorrect flow data.

61. D — The pump is already at 100% speed — it cannot go faster. The options are: start the second RAS pump to add capacity, or investigate whether the system head can be reduced by opening partially

closed valves or clearing pipeline restrictions. A VFD should never be operated above 100% (60 Hz) as this over-speeds the motor and risks mechanical damage.

62. A — The cracked tubing at the pump head is not only losing chemical (reducing the actual dose delivered) but is also creating a polymer spill on the floor — an extremely dangerous slip hazard. Regarding chemical delivery, the crack will worsen progressively and eventually rupture completely. The pump should be shut down, the cracked tubing replaced, and the spilled polymer cleaned up immediately.

63. B — At 50 GPM × 30 min × 6 cycles = 9,000 GPD actual output based on the pump settings. The flow totalizer showing 25,000 GPD is nearly three times the calculated volume, indicating the totalizer has malfunctioned. Common causes include a signal processing error, a faulty pulse counter, or interference in the flow sensor. The totalizer should be verified and recalibrated.

64. C — VFD-controlled motor speed is directly proportional to the output frequency. Speed = (Output Hz ÷ Rated Hz) × Rated RPM = (55 ÷ 60) × 3,600 = 3,300 RPM. This linear relationship between frequency and speed is the fundamental operating principle of variable frequency drives — reducing the frequency by the same percentage reduces the motor speed proportionally.

65. D — Gas detection sensors degrade over time — the active sensing element loses sensitivity gradually. A sensor may respond adequately to a bump test concentration (typically 50% of the alarm setpoint) but fail to read accurately at the critical alarm concentration or at lower concentrations where early warning is most important. The manufacturer's end-of-life date reflects tested degradation data.

66. A — In cold weather, a failed block heater means the engine oil is cold and viscous (requiring more cranking effort), the engine block and cylinders are cold (reducing fuel atomization and combustion efficiency), and the starting batteries must work harder against the cold, stiff oil. These factors combine to significantly increase the risk of a slow or failed start during an actual power outage.

67. B — A pump motor running with zero discharge pressure and suction vacuum confirms the pump has lost its prime — it is spinning on air. The suction vacuum shows the impeller is creating low pressure on the suction side, but without a continuous liquid column from the source, it cannot develop discharge pressure or deliver flow. The pump must be reprimed before it can resume pumping.

68. C — When the blower runs at 100% but the DO cannot reach setpoint, the oxygen supply is insufficient for the demand. Multiple causes can produce this symptom: a fouled DO probe reading low

(causing unnecessary full-speed operation), fouled diffusers reducing oxygen transfer, or a partially closed valve restricting airflow. All three should be investigated systematically before concluding the system is undersized.

69. D — Identical flow, loading, MLSS, and blanket depth but different effluent quality between two identical clarifiers points to a physical difference in the clarifier structure. An uneven weir, fouled launder, damaged center well, missing baffle, or structural damage creates preferential flow paths that carry solids over the weir in Clarifier B. A thorough physical inspection will reveal the defect.

70. A — Infrared thermographic hot spots at electrical connections indicate high-resistance points where electrical energy is being converted to heat. Loose terminals, corroded contacts, or insufficient torque allow micro-arcing and resistance heating that can reach temperatures capable of melting insulation, igniting surrounding materials, or triggering an arc flash. The connection must be de-energized and repaired.

71. A — At the same withdrawal flow rate (8,000 GPD), a thinner sludge (4.2% vs. 6.0%) contains significantly less total solids mass per gallon. The digester is receiving less volatile solids feed per day — fewer organics for the methane-forming bacteria to convert. The 30% decrease in solids concentration directly explains the 20% decrease in gas production.

72. C — Non-uniform cake solids across the belt width — significantly wetter on the right edge (15% vs. 22% on the left) — indicates uneven compression. The most common cause is uneven belt tension — if the right side has less tension, the rollers cannot apply adequate pressure on that side, leaving more water in the cake. Belt tension adjustment or roller alignment will correct the distribution.

73. D — Hydrogen is a key intermediate metabolite in anaerobic digestion — acid-forming bacteria produce it, and methane-forming archaea consume it. When the methanogens are stressed or inhibited, they cannot consume hydrogen fast enough, and it accumulates. Rising hydrogen (0.1% → 0.5%) is often the earliest indicator of developing digester instability, preceding volatile acid increases and pH drops.

74. B — Food waste co-digestion produces digested sludge with higher volatile solids content. The biological cell material from food waste digestion contains a greater proportion of bound water — water trapped within the cellular structure that is difficult to release even under centrifugal force. This biologically bound water reduces the achievable cake dryness compared to sludge from conventional digestion.

75. B — Turning moves the cooler perimeter material (115–125°F) to the center where it will be exposed to the thermophilic temperatures needed for pathogen destruction. Simultaneously, the hot center material is moved to the outside where it begins to cool. This ensures all material in the pile eventually experiences the pathogen-killing temperatures, which is essential for meeting Part 503 requirements.

76. B — Total digester volume = 3 × 200,000 = 600,000 gallons. HRT = 600,000 ÷ 15,000 = 40 days. This detention time is within the typical range of 15–30 days (some references extend to 45 days) and provides ample time for the three-stage anaerobic biological process. The conservative loading ensures stable operation and adequate volatile solids reduction.

77. D — Achieving Class A pathogen reduction with a thermal dryer requires demonstrating that the specific drying process meets one of the Part 503 PFRP alternatives — including validated time-temperature criteria for the drying process. Simply achieving a low fecal coliform result is necessary but not sufficient; the process itself must be validated as an approved PFRP alternative through repeated testing.

78. C — Part 503 specifies that for Class B biosolids applied to land where turf is grown for placement on lawns or land with high potential for public exposure, the turf cannot be harvested for 1 year after biosolids application. This extended restriction protects public health by ensuring adequate pathogen die-off before the turf is placed where people, especially children, may have direct contact.

79. A — The 65% moisture content exceeds the optimal 50–60% range, and the anaerobic center with sulfide odor confirms insufficient oxygen penetration. Turning reintroduces oxygen throughout the pile, and adding dry bulking agent reduces the moisture content. The increased turning frequency during curing prevents future anaerobic zones from developing. These combined actions restore aerobic conditions.

80. C — Increasing the bowl speed by 10% increases the centrifugal force (proportional to RPM^2) by approximately 21%. The greater centrifugal force improves solids compaction on the beach (drier cake) and enhances separation of fine particles from the centrate (clearer liquid). Both aspects of separation benefit from the increased force.

81. D — Van Kleeck: VSR = [(0.72 – 0.55) ÷ (0.72 – (0.72 × 0.55))] × 100 = [0.17 ÷ (0.72 – 0.396)] × 100 = [0.17 ÷ 0.324] × 100 = 52.5%, approximately 53%. This exceeds the 38% minimum for Part 503 vector attraction reduction, indicating effective digester performance and well-stabilized biosolids.

82. A — Solids mass conservation: 10,000 gal × 0.035 = 350 gallon-equivalents of solids. At 22%: 350 ÷ 0.22 = 1,591 gallons of cake. Volume reduction = (10,000 – 1,591) ÷ 10,000 = 84%. Dewatering from 3.5% to 22% reduces the volume by approximately 84%, producing roughly 1,590 gallons of cake per day from 10,000 gallons of feed.

83. C — The soil pH of 5.5 is below the state's minimum of 6.0 for biosolids application. Agricultural lime (calcium carbonate) must be applied to raise the soil pH above 6.0 before the next biosolids application. Low soil pH increases the bioavailability of heavy metals, potentially allowing them to enter crops, leach to groundwater, or become toxic to soil organisms.

84. B — Dry solids = 20,000 GPD × 8.34 × 0.04 = 6,672 lbs/day = 3.336 dry tons/day. Polymer = 15 lbs/dry ton × 3.336 tons = 50 lbs/day. This calculation converts the volumetric feed to dry weight, then applies the polymer dose rate per dry ton to determine the daily polymer consumption. Accurate polymer budgeting prevents both underdosing (poor conditioning) and overdosing (wasted chemical cost).

85. D — During the 3-week incinerator shutdown, the plant needs a practical, permitted alternative for managing approximately 3 weeks of biosolids production. Transportation to a permitted landfill that accepts biosolids is typically the most practical and quickly arranged option. Temporary land application may also be feasible if a permitted site is available. On-site storage is limited and may not be adequate.

86. A — Biofilter media must maintain a moisture content of 40–60% for the odor-degrading organisms to remain biologically active. If the media dries out, the organisms become dormant or die, and the biofilter loses its ability to biologically oxidize odorous compounds. Re-wetting the media with a sprinkler system or manual irrigation typically restores biofilter performance.

87. C — A rising digester cover with normal gas production and stable sludge level indicates the gas is being produced normally but cannot flow out at the normal rate. A blockage or restriction in the gas collection piping, the gas meter, the flame arrestor, the pressure regulator, or the gas utilization equipment prevents normal gas flow, causing pressure to accumulate under the cover.

88. B — A white precipitate in an acid-preserved metals sample is not uncommon — some metal compounds initially precipitate when acid is added but redissolve over time, or calcium sulfate may form from the reaction of calcium in the sample with the sulfuric acid. The sample should be vigorously shaken before taking an aliquot to ensure all precipitate is resuspended and included in the analysis.

89. D — Although all five monthly results are below the 200 CFU/100 mL limit, the March spike to 180 represents 90% of the limit — an uncomfortably thin compliance margin. A proactive operator investigates spikes even when they don't cause violations, because understanding the cause enables prevention. If the March condition recurs with slightly worse timing or magnitude, a violation could result.

90. A — Dissolved oxygen changes rapidly after collection — CO_2 exchange with the atmosphere, temperature equilibration, and continued biological activity all alter the DO from its in-situ value. The most accurate effluent DO measurement uses a calibrated portable meter placed directly in the effluent stream, eliminating all transport-related artifacts.

91. B — A consistent three-month upward trend in effluent TSS (8 → 12 → 18 mg/L) is not random variation — it indicates a progressive process deterioration. Waiting for the TSS to approach or exceed 30 mg/L before investigating wastes the lead time needed for corrective action. The operator should investigate NOW while the margin exists to diagnose and fix the problem before a violation occurs.

92. C — An uncalibrated balance may have drifted, producing systematically biased TSS results. The 5-month gap means all TSS data during that period has uncertain accuracy. The balance should be immediately calibrated, and if significant drift is detected, the magnitude and direction should be documented and the regulatory authority notified of the potential data quality issue affecting the affected DMR periods.

93. D — A chronic NOEC of 50% means the effluent causes observable toxic effects at concentrations above 50%. Since the permit requires NOEC ≥100% (no toxicity at full strength), the effluent is toxic and the plant has failed the WET test. The standard investigative approach is a Toxicity Identification Evaluation (TIE) to identify the toxic component(s) followed by a Toxicity Reduction Evaluation (TRE) to eliminate the source.

94. A — Three consecutive GGA results of 195, 202, and 198 mg/L — all within the 167.5–228.5 acceptance range and clustered tightly around the 198 mg/L target value — demonstrate excellent precision (results are consistent) and accuracy (results are close to the true value). This confirms the laboratory's BOD_5 analytical system is performing correctly.

95. C — The holding time begins when the first aliquot is collected (8:00 AM yesterday) and expires 48 hours later (8:00 AM tomorrow). Current time is 10:00 AM today = 26 hours elapsed. Remaining time = 48 – 26 = 22 hours. The laboratory must begin the BOD_5 setup (dilutions, seeding, initial DO measurement) within 22 hours.

96. B — SVI = (380 × 1,000) ÷ 3,800 = 100 mL/g. The settling curve shows the sludge initially occupies 750 mL (only 250 mL of clear supernatant after 5 minutes) but continues compacting to 380 mL by 30 minutes. This pattern — moderate initial settling followed by good compaction — indicates healthy floc structure with an SVI of 100 mL/g, confirming good settling characteristics.

97. D — Some combined chlorine forms (particularly dichloramine and organic chloramines) require higher doses of sodium bisulfite or longer reaction times to neutralize than free chlorine. If the effluent contains persistent combined chlorine species that react slowly with the dechlorination agent, a residual will be detected by the DPD method even after the system has removed all free chlorine and most combined chlorine.

98. C — A reagent blank should produce a result at or near zero — it measures the background contribution of the analytical system itself. A 12 mg/L blank indicates contamination in the distilled water, glassware, reagents, or laboratory environment that is adding oxidizable material to every sample processed through the procedure. All results from this analytical run are biased high by approximately 12 mg/L.

99. A — In real wastewater treatment, the BOD/TSS ratio varies naturally from sample to sample due to changes in the proportion of soluble vs. particulate BOD, variations in the biological community, and analytical variability. A perfectly consistent 60% ratio for 8 consecutive months is statistically implausible and raises a serious concern about potential data fabrication or calculation from a formula rather than independent analysis.

100. B — Three consecutive PT results below the assigned value (8.2, 8.5, 8.8 vs. 10.0 target) demonstrate a systematic negative bias — the laboratory is consistently underreporting the true ammonia concentration. While each result individually falls within the broad acceptance range, the pattern indicates a method problem (perhaps low recovery during digestion, calibration curve issues, or reagent degradation) that should be investigated and corrected.